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THE PRODUCTION OF GROWTH BY THE ACTION OF THE PITUITARY GLAND ON THE VASCULAR AND HEMOPOIETIC SYSTEMS

INTERRELATIONSHIP BETWEEN THE LUNGS AND THE PITUITARY GLAND*

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IT IS the purpose of this paper to present evidence supporting the view that the pituitary gland produces growth by the formation of blood vessels and by supplying blood to the tissues. Furthermore, it will be shown that there is a reciprocal relationship between the lungs with their vital functions of oxygenation, and respiratory water metabolism and the pituitary gland. The influence of this gland on the mesodermal vascular and hemopoietic systems is of particular interest in this paper.

That growth may and does take place by virtue of an increase in the number of blood vessels and blood supply to a part is shown in the condition, arteriovenous fistula. In this departure from the normal blood supply, growth proceeds without the presence of a pituitary eosinophil adenoma or hyperplasia and most certainly without a generalized increase of the anterior pituitary hormone. There is present, as a rule, an enlargement of the soft tissues as well as of the bones in the affected part. This represents a localized gigantism or acromegaly.

Horton[20] reported 23 cases of hemihypertrophy of the extremities associated with arteriovenous fistula. The report covered a period of two years at the Mayo Clinic. That the increase in blood flow to an extremity may alter the normal growth of bones is shown in these cases of arteriovenous fistula. Horton said that the fact that the age of the patient can be estimated fairly accurately by the degree of ossification of various bones is well known. If the ossification of the wrist and hand in one of his cases were offered in evidence of age it would be valid only as applied to the right (normal) member. Three carpal bones were ossified in the normal member with the arteriovenous fistula. The anatomic age of the right hand was approximately five years but the subject's age was only three years. It is of interest that in 5 of Horton's 23 cases, hypertrophic arthritis was present in the terminal joints of the involved extremity and bone atrophy was present in 2 cases.

In Figure 1 is shown an amputated hand with an acquired arteriovenous fistula injected with red lead. Despite the suturing of the radial and ulnar arteries with result-

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Fig. 1. Hand with arteriovenous fistula showing decreased blood supply due to ligation of radial and ulnar arteries. Cirsoid conditions of vessels is well shown.

ing retardation and diminution of the blood supply, the tortuosity of the blood vessels and great vascularity of the hand are apparent.

In 18 of Horton's cases there was an increase of 0.5 to 7 cm. in the length of the bones in the abnormal extremity. The temperature was from 1 to 6.5° higher than in the corresponding extremity. The oxygen saturation of the blood from the veins of the affected extremities was invariably higher than the normal extremities. This same difference was noted in intracranial arteriovenous fistulas by studying the oxygen content of the internal jugular vein.

If an arteriovenous fistula can produce an overgrowth of an extremity by increasing the blood supply, is it possible that the pituitary produces body growth by developing the circulatory system of the body and by the production of blood? If so, then there is no need to assume the presence of the so-called specific hormones or polyhormones since all endocrine glands would be affected by this mechanism. Not alone would the endocrine glands be affected but the body as a whole.

Certain states of congenital hypopituitarism are associated with defective growth development resulting in dwarfism. In the congenital condition cretinism, dwarfism is also present and as pertinent to the present discussion, the state of the pituitary in this disease is of paramount importance. In a review of the pituitary findings in cretinism and congenital hypothyroidism, it was found that this gland "undergoes structural changes. The majority believe that hyperplasia is present, confined almost entirely to the chromophobe or chief cells. Some believe that the gland atrophies. From a clinical standpoint everything points to a hypofunction of the pituitary in the hypothyroid state. Enlargement of the gland does not necessarily mean, as some believe, an increased function. Cretinism with goiter certainly does not indicate that the goiter is an actively secreting gland but, on the contrary, is a degenerative type of gland enlargement."[46]

Since the pituitary function is reduced in cretinism, then the capillary and vascular system development should in this congenital and developmental state be aplastic or show evidence of maldevelopment. This is based on the assumption that a normally functioning pituitary is necessary for a normally developed vascular system. Since the evidence favors the view that the pituitary is a congenitally underfunctioning gland in cretinism, then the state of the

vascular system in this disease should be an undeveloped one and so it is found. Some of the evidence is as follows: Starlinger,[59] withdrawing blood from the veins of cretins noted that this could be performed much easier in those with a goiter than in those without. He therefore concluded that the vascular system in hypothyroidism remains in a hypoplastic condition if the disease is present during the first years of life. If, however, hypothyroidism is present later in the developmental period of life, this hypoplastic state of the vascular system does not take place and normal conditions prevail.

DeQuervain and Wegelin[55] said that four-fifths of all cretins show moderate to severe changes in the capillaries. Gehri,[13] of Wegelin's Clinic, studied the capillary system of 155 cretins. She found that the more severe the grade of cretinism, the more severe the grade of capillary system disturbance. Ninety-three of the 155 belonged to the severe type of cretinism. And in this group 3.2 per cent showed normal capillary development, 9.6 per cent showed mild involvement, 39.7 per cent were moderately affected and 47.5 were severely affected.

The condition of the capillaries as found in cretins by Gehri has been substantiated according to Wegelin by Jaensch, Gunderman, Wittneben, Müller and Bock. Wegelin stated that no athyreotic individual or cretin ever shows a fully normal capillary picture. It is the pituitary gland, being in a hypofunctional state in cretinism, which accounts for the pathological capillary findings and not the thyroid gland.

An example of the influence of the pituitary gland on the capillary system is seen in the congenital defective condition, anencephalus. It has been found that the pituitary gland is defectively developed in that group of cases in which the anterior portion of the cerebrum is involved. This leads to the condition, apituitarism, and is a true congenital apituitarism. Many writers have shown the defective development of the pituitary in anencephalus.[4,6,8,10,31,32,33,42,50] It has been shown that the adrenal cortex is defectively developed in this condition and is secondary to the pituitary defect.[44] Cushing[9] agreed with this view. He stated that nature performed for us a hypophysectomy in the anencephalic fetus with resulting hypopituitarism associated with aplasia of the adrenal cortex.

The whole vascular system as well as the heart is poorly developed in anencephalus and it is reasonable to assume that since the syndrome has the features of apituitarism the pituitary is also responsible for the vascular-cardiac underdevelopment and the latter is the prime cause of the hypoplastic state of the viscera and stunted body growth.

As is known, the pituitary influences the phenomenon of menstruation and it exercises control over blood vessel development of the myometrial endometrium mediated probably by the estrogenic and progestational hormones. We know that the anterior lobe initiates and maintains gonadal function and is a factor in inducing menstrual bleeding. The development of the capillaries in the endometrium is of great importance and it seems safe to say that the pituitary is necessary for the development of the endometrial capillary system. This would also hold true for the vascular system of the placenta of pregnancy.

The assumption that the chromophil cells of the pituitary control the development of the capillaries and hemopoiesis plus the well known pharmocologic effect of the posterior lobe on the capillaries would furnish a logical explanation for the phenomenon of menstruation. While it is not the purpose of this paper to enter into a lengthy discussion of menstruation, nevertheless if the principles as outlined in the paper are presumptively correct then there is a logical explanation for this function.

Hartman,[17] in a recent review, "presented informally what appear to be the more basic facts which must be considered in formulating a working theory on the cause of menstruation." The observations of Markee[41] on the vascular phenomena seen in intraocular endometrial transplants are stressed.

Hartman, basing his observations on the work of Markee, said: "The vascular changes preceding menstruation, whether in a normal ovulatory or an anovulatory cycle, or after cessation of estrogen, progesterone or any other steroid, are practically the same."

He then goes on to describe four stages of the vascular changes: 1. Stasis, with or without general vascular dilatation in the transplant, occurs one to five days before the flow. This is the stage of congestion. 2. A constriction of the spiral arteries occurs four to twenty-four hours before the hemorrhage. The blood is thus shut off from the area supplied by the artery and a marked blanching of the field results. Necrosis of the tissues which ends in sloughing is most probably due to the anoxia begun during the stage of stasis and completed with the anemia just described. This stage is always present. 3. Hemorrhage from capillary, arterioles and venules. 4. "A cessation of bleeding takes place through the final constriction of the arteriole. According to Daron, this constriction may occur as far back as the myometrium but in Markee's experiments endometrium only was transplanted. Markee's chief contribution centers about the phenomenon of regression. It is the common denominator of menstrual bleeding from every type of endometrium. Observing it in the ocular transplant it is possible to predict the approximate hour of uterine bleeding."[17]

He is of the opinion that an extragonadal influence on rhythms in the female genital tract seems certain. "To discover what this influence is (adrenal? posterior pituitary?) may eventually be of real significance for the explanation and control of uterine pathology."

One could readily postulate that the anterior lobe of the pituitary with its eosinophil and basophil cells produced the development of the endometrial capillaries and the blood, mediated by the estrogenic ovarian hormone of the ovary and the chromophil cells of the pituitary. Then around the fourteenth day of the menstrual cycle the antagonistic progestational hormone of the corpus luteum inactivates the posterior lobe hormone of the pituitary permitting the secretory phase of the endometrium to develop with its vascular Swiss cheese pattern of spiral capillaries. However, if gestation does not take place then the posterior lobe secretion, near the end of the menstrual cycle, probably a few hours before the flow, overcomes the decreased corpus luteum secretion, and constriction of the arteries occurs. It is of course well known that the corpus luteum degenerates towards the end of the menstrual cycle and, furthermore, the antagonistic action of the progesterone and posterior pituitary secretions is well known.

Thus both the anterior and the posterior lobes of the pituitary with their respective actions play a major rôle in the phenomenon of menstruation.

Certain facts indicate that the eosinophil cell of the pituitary is responsible for the vascular system development whereas the basophil cell produces hemopoiesis through stimulation of the reticulo-endothelial system. There is a close relationship between the chromophil cells as well as the adenomas formed from these elements. Their juxtaposition anatomically is also shown in their physiological relationships. The eosinophil adenoma produces gigantism or acromegaly and the basophil adenoma, basophilism or Cushing's syndrome. In both conditions there are found, as a rule, the following:

1. Osteoporosis.
2. Hypertension.
3. Hyperglycemia, glycosuria, or a lessened glucose tolerance.
4. Erythremia or a tendency to polycythemia.
5. Amenorrhea in the female and impotency in the male.
6. Weakness and ease of fatigue.
7. Hirsutism.

The eosinophil cell produces growth of the body by its ability to develop the vascular system. If this is true then it becomes a corollary that a normal or near normal de-

velopment of this system is essential for growth, otherwise the nutritive elements of the blood would not be delivered to the protoplasm of the cell. The very size of the tissues indicates that there is an increased development of the vascular system in acromegaly and gigantism and this has been demonstrated in these conditions. At least two essential factors for growth are produced by the pituitary, the vascular system and the blood. Growth is accomplished by the hormones of the pituitary which bring about the formation of the vascular system and the blood forming elements. Thus one could understand the far reaching effects of the pituitary gland so that by the formation of these basic elements its effects are felt in all parts of the body. Its euphonious title, "leader of the endocrine orchestra," is well chosen.

As justification for the view that the pituitary is a major factor in the development of the vascular and hemopoietic systems, further data are herewith submitted:

In renal rickets or renal dwarfism, pituitary defects with diabetes insipidus are one of the most frequent findings. Bader[3] showed that there is *defective development of the systemic blood vessels as well as of the renal glomeruli*. Congenital lesions of the heart are common as is cardiac hypertrophy associated with degenerative myocardial muscular changes. Mitchell[43] found cardiac enlargement in 46 out of 78 cases of renal dwarfism. Amenorrhea, imperfect development of genitalia and breasts is a frequent finding. Of 78 cases reviewed by Mitchell, 64 had polyuria. Secondary anemia was present in all cases. The latter finding and the defective development of the systemic blood vessels help in a large measure to explain the dwarfism. In view of the pituitary defect, it is a natural assumption that this gland is responsible, among other things, for the defective vascular system development as well as for the anemia.

Moehlig and Bates[47] reviewed the literature on the influence of the pituitary on erythrocyte formation. It was concluded that "the pituitary has a very important influence on erythrocyte formation. Primary disease of the suprarenal cortex results in secondary pituitary changes thus accounting for many signs and symptoms erroneously ascribed to the suprarenal cortex. The specific and selective embryohormonic relations of the pituitary gland to mesodermal tissues is a reasonable explanation for the polymorphic signs and symptoms of pituitary disturbances."

We showed by experimental work on dogs that bilateral adrenalectomy produces soon after this operation a pronounced increase of the pituitary basophil cells associated with polycythemia. Our findings are similar to those of others while another group reported hypoplasia of the pituitary after this operation (literature by Herrick and Finerty,[18] Moehlig and Bates[47]). Recently White and Dougherty[65] found that continued daily injections of adrenotrophic hormone into mice resulted in an increase in hemoglobin and red cells, an absolute lymphopenia and an increase in polymorphonuclear leukocytes. By means of its trophic influence on the adrenal cortex, pituitary adrenotrophic hormone maintains a physiological control over the numbers of circulating erythrocytes and lymphocytes. One may also assume that the hormone stimulates the whole reticulo-endothelial system, including the bone marrow, such as is seen in the case reported with adrenal cortex tumor and pituitary basophilism. These authors cite the work of others showing the influence of the pituitary on erythrocyte formation.

In Addison's disease, in which there is a more or less gradual loss of adrenal tissue and function, the pituitary is found to be in a degenerative state.

Poos,[53] in a large series of experiments using various animals, showed that the pituitary reacts qualitatively in the same way when other glands of internal secretion are disturbed by experimental attack. The quantitative differences are dependent upon the severity of the endocrine changes produced and secondarily, upon the length of the experiment. He differentiated four

stages of reaction processes affecting the pituitary after adrenalectomy: (1) the stage of increased physiologic reaction; (2) the stage of pituitary hydrops; (3) the stage of degeneration; (4) the stage of pigment formation. Much, therefore, depends upon the stage when the pituitary is examined after adrenalectomy. If examined soon after operation the gland will be found in the stage of increased physiologic reaction, whereas in later development it will show the stage of degeneration. Thus one can reconcile the opposite views of the two groups.

Infantilism is usually associated with a pituitary disturbance and, as Wolf[68] said, all cases of infantilism have some degree of pituitary involvement, whatever the ulterior cause of the retardation may be. The tissues are usually poorly developed, showing itself in an infantile type of heart and narrowness of the circulatory system. It is evident that a normal or near normal development of this system is essential to growth.

As previously stated, it seems quite likely that the chromophil cells of the pituitary, the eosinophil and basophil, are synergistic in action and the adenomas of these cells have certain symptoms and findings in common. Both types have the ability to produce an increased blood volume and hemopoiesis but only the eosinophil hyperplasia or adenoma causes bodily overgrowth such as acromegaly and gigantism. It is a foregone conclusion, however, if the hypothesis is correct, that the basophil cells participate in these diseases in order to bring about hemopoiesis. The increase in size of an extremity by vascular formation and an increased oxygen saturation above normal are seen in arteriovenous fistula. This is supportive evidence that growth as seen in pituitary overactivity is produced in this manner. The growth of youthful individuals suffering from hyperthyroidism is well known. Holmgren,[19] for instance, showed that these patients grew faster than normal, that is attain their adult growth faster than normal. The height they reach is, of course, dependent to a great extent upon hereditary and constitutional factors. In hyperthyroidism the circulating blood volume is much increased and the oxygen consumption is greater than normal as shown by the increased metabolic rate. The vascular system of the growing individual increases in extent.

The state of the pituitary in hyperthyroidism has been reviewed elsewhere and the majority opinion seems to be that in this disease the pituitary is overactive; hyperemia of this gland is usually present.[45]

That there is an increased functional activity of the neighboring hypothalamic area is most likely in view of the symptoms seen in hyperthyroidism. Another disease showing the pituitary-vascular-hemopoietic system relationship is hypertrophic pulmonary osteoarthropathy. Changes in the pituitary have been described in this disease. Fried,[12] for instance, reported 4 cases of pulmonary osteoarthropathy associated with bronchiogenic cancer in which evidence was presented to show that the condition is, in all likelihood, caused by an endocrine imbalance (dyspituitarism). All 4 patients had bronchiogenic cancer and symptoms of acromegaly. Three came to autopsy and revealed hyperplasia of the eosinophil cells of the pituitary. The fourth case was not autopsied but had acromegaly.

It was shown by the sequence of events in the history and findings that the bronchiogenic cancer antedated the acromegaly for as Fried said "apparently the osteoarthropathy reached considerable dimensions when the neoplasm was still small." It is reasonable to suppose that the pituitary eosinophil cell hyperplasia was secondary to the bronchiogenic cancer and the former caused the osteoarthropathy and acromegaly.

Fried dismissed the theory that a toxin causes the glandular changes in osteoarthropathy. Locke,[38] in an extensive review of chronic pulmonary hypertrophic osteoarthropathy, found that acromegaly is so closely related to the former condition that some authors, whose cases were re-

viewed, reported them to be pulmonary osteoarthropathy. He was of the opinion that the changes in the skeleton in a well developed case of secondary hypertrophic osteoarthropathy are seldom confined to the bones of the forearm, hands, lower legs and feet as so often described. He suggested that the bone changes were similar or identical with the appearances of acromegaly. He showed that the bone changes were not confined to the diaphyses, but all well established cases showed a very marked new formation of bone in the epiphyseal portion. The marrow showed various changes and was often embryonic. This is like the change seen in polycythemia associated with an adrenal cortex tumor and

Fig. 2. Roentgenogram of chest showing infiltrative lesion of right lung producing clubbing of fingers. (Chronic pulmonary osteoarthropathy.)

lung metastases. The periosteum is thick and vascular. The tissues are thickened and the capillaries are dilated. Illustrative of these findings is the following brief summary of a case.*†

* I wish to thank Dr. Louis Carbone for permission to report this case.

† This patient has since died and the postmortem showed a bronchiogenic carcinoma. Unfortunately permission for postmortem of the head could not be obtained.

Fig. 3. Clubbing of the fingers. The enlargement of the third finger distal phalanx is due to trauma and clubbing.

An Italian laborer, aged sixty-one, was seen on April 26, 1945, with dyspnea, cough, and swelling of the fingers and toes. Symptoms were of four months' duration. Roentgenograms of the chest revealed an infiltrative type of lesion in the area of the right lobe (Fig. 2). The lesion had been increasing in size and a biopsy obtained by bronchoscopy showed merely chronic inflammatory changes. Clubbing of the fingers was present. The third finger of the right hand showed a marked enlargement of the distal phalanx due to an old injury as well as to the clubbing (Fig. 3). The toes also showed clubbing but to a lesser degree. The femur, tibia and fibula showed marked proliferative changes of the periosteum (Fig. 4 and 5). The hemoglobin was 82 per cent (Sahli) and the red cell count was 4,080,000 and the leukocyte count 11,000. The glucose tolerance test was: fasting sugar 103 mg. per 100 cc.; ¾ hour—180 mg.; 1½ hour—185 mg.; 2½ hour—180 mg. The disease is a progressive one and we feel certain that it is due to a neoplasm of the lung despite the unsatisfactory biopsy report.

This case illustrates the marked clubbing of the fingers and toes characteristic of chronic pulmonary osteoarthropathy due

Fig. 4. Bony overgrowth of femur, tibia and fibula. Sclerosis of patella is well shown. (Chronic pulmonary osteoarthropathy.)

to a lesion of the lung, apparently a carcinoma. The marked proliferation of the periosteum of the long bones is an outstanding feature of the roentgenograms. As has been shown, the thickened periosteum is very vascular with dilated capillaries and is strong supportive evidence that the chromophil hyperplasia of the pituitary is responsible for these changes.

The lessened glucose tolerance is also probably due to the same pituitary changes.

Eosinophil cell hyperplasia of the pituitary would, as postulated in the article, be responsible for the vascular changes. As shown, these cells are most frequently hyperplastic in chronic pulmonary osteoarthropathy but the basophils no doubt also participate in the disease.

The close association between acromegaly and hypertrophic pulmonary osteoarthropathy has been recognized for many years. Packard[51] discussed this relationship at an early date (1892). Field,[11] Jolly,[29] Murray[49] and Thayer[63] are just a few who have reported on this association.

Locke[38] reported a case with hyperplasia of the pituitary chromophil cells associated with primary carcinoma of the lung. Benda[5] reported an interesting case that had hyperplasia of the pituitary basophil cells and a diminution of the eosinophils. He termed his case "pseudo-acromegaly." This is of interest in that we usually find eosinophil cell hyperplasia or adenoma formation in association with acromegaly or the acromegaloid findings of pulmonary osteoarthropathy. It has been stated that the chromophil cells must be closely related physiologically and chemically, and their anatomical juxtaposition make this seem likely. The chromophobe cells are supposed to be the mother cells of the chromophil cells.

Since hyperplasia of the pituitary chromophil cells is associated with primary carcinoma of the lung, it is of interest that the pituitary shows histological changes in cancerous patients. Houssay[21–27] stated that there has been found an "increase in the principal cells, increase or decrease of

Fig. 5. Anteroposterior view of femur, tibia and fibula showing bony overgrowth associated with chronic pulmonary osteoarthropathy.

the basophils, increase in the weight of the gland and in the number of eosinophils, signs of hyperactivity of the anterior lobe, and hypoactivity of the posterior. In rats with subcutaneous implantation of tumors, there is an increase and vacuolization of the basophil cells of the pituitary, with enlargement of their Golgi apparatus. The changes are similar to those produced by castration; although the sexual cycle is not affected. If these pituitary glands are then implanted into immature rats, it can be demonstrated that they have an increased gonadotrophic activity. If the cancerous implantation is made into the uterus there is a larger increase of the eosinophil cells of the pituitary and less of the basophiles and the pituitary appears like that of pregnancy or after the injection of estrin."

Kraus[35] described the hyperplastic changes in the pituitary in various diseases, such as in athyreosis and hypothyreosis. In these diseases he described a special cell which he termed "Kraus' thyroprival cell." With reference to the changes in the pituitary in malignancy he also described hyperplastic changes. He stated that both carcinoma and sarcoma produced hyperplastic changes in the anterior lobe. However, the reports in the literature are not all uniform. Kraus explained the differences as follows: "The dependence of the cytological picture in the anterior lobe upon various factors, such as age, state of gonads, obesity, contracted kidneys, hypertension, etc., makes it conceivable that in cases of carcinoma or sarcoma these factors may influence the changes produced by the malignant tumor."

These findings in cancerous patients are of great significance. It would seem, therefore, that the pituitary changes are not specific for cancer of the lung. However, there is no discounting the fact that in pulmonary osteoarthropathy without cancer of the lung there are pituitary changes. One is forced to the conclusion that primary lung changes result in secondary pituitary chromophil cell hyperplasia.

The possibility exists that a neoplasm of the lung activates the chromophil cells by two methods: first, as we have seen, the presence of cancer results in chromophil changes in the pituitary and second, its location in the lung induces further activation of these cells. The fact that the bone changes in pulmonary osteoarthropathy are like those found in acromegaly lends support to the view that the pituitary is responsible for the osseous changes. Other lung and cardiac conditions produce clubbing of fingers and toes but there is no acromegaly or polycythemia. Particularly does bronchiectasis produce clubbing. This is probably circulatory in origin with stasis in the periphery like that seen in arteriovenous fistula.

The osseous changes in the fingers as seen in pulmonary osteoarthropathy again indicate that an increased blood supply is responsible for the bony overgrowth. One can hardly escape the conclusion that the increased blood supply to the tissues induced by pituitary-eosinophil hyperplasia or adenoma formation is the direct cause of acromegaly and gigantism with the clinical manifestation of osseous and visceral overgrowth.

It seems likely that the capillary system and the hemopoietic system with the varying rate of oxygenation in these systems as well as the speed of the circulating blood volume will affect the development and function of all the endocrine glands. Such an effect readily explains why the term "master gland" is applied to the pituitary.

The close relationship existing between the pituitary and the vascular hemopoietic system is further illustrated by the pharmacological effect of the posterior pituitary lobe extract on certain *mesodermal* derivatives. These are: a vasoconstrictor effect on the capillary vascular systems; an antidiuretic effect on the renal tubules and glomeruli; a stimulating effect on the pigment cells of the frog; a constricting effect on the smooth muscles such as the uterus, intestines and bladder.

That the posterior lobe maintains capillary tone is shown by the work of Krogh.[36]

This investigator found that a few hours after complete extirpation of the pituitary in the toad, the capillaries and arterioles of the skin became dilated. Injection or perfusion of posterior lobe extract (pituitrin) even in doses of 1:1,000,000 re-established the capillary tone. Larger doses produced a contraction of the arterioles as well. From these facts he concluded that the pituitary, by means of a hormone, had a continuous action of the tone of the capillaries.

It would seem, therefore, that the data support the contention that the pituitary gland as a whole is important to the vascular system.

As is known, the anterior lobe produces changes in the adrenal cortex but the posterior lobe also does so. Osius and I[48] injected rabbits with posterior lobe extract (pituitrin) for one hundred days. The average adrenal weights of the normal control rabbits was 278 mg. while that of the injected group was 415 mg. The microscopic examination revealed that the increase of the adrenals was confined to the cortex. In addition to this, we produced arteriosclerotic changes in rabbits' arteries by injecting posterior lobe extract and feeding large doses of cholesterol containing substances (lanolin and cotton seed oil).

Hypophysectomy in rats having mammary gland carcinoma resulted in slowing the rate of growth of the transplants in hypophysectomized rats. These findings suggest that the tumors growing in the hypophysectomized rats were less adequately vascularized than those growing in normal rats (literature by Van Dyke[64]). The lessening of the vascularization bears out the opinion that growth is dependent upon a normal pituitary maintaining a normal blood supply. Naturally, growth is slowed by this process. It is an incontestable fact that no matter how adequate the diet may be in hypophysectomized animals, they will not grow unless growth promoting hormone is also administered. It is of some significance that there is an increased amount of water in the animals receiving growth extract. This, as well as an increase in the protein or total nitrogen in the tissues of animals injected with growth extract, indicates that these elements are necessary for growth. It has also been shown that tumor growth parallels body growth to some extent (Van Dyke).

From the known facts that a cancer produces hyperplastic changes in the pituitary and that pulmonary osteoarthropathy is also associated with similar pituitary changes certain suggestive speculations are permissible. For instance, one might be tempted to suggest that an embryonic type of tissue in the lung, such as a cancer, might produce a reaction in the pituitary. This would, of course, be specific for lung tissue, but the disease, pulmonary osteoarthropathy, is also associated with chronic purulent conditions of the lungs. Is the location of the neoplasm in the lung or the chronic purulent condition of the lung (even though involving a small amount of pulmonary tissue) sufficient to stimulate the pituitary changes? Is there enough change in the lung to interfere with the vital function of oxygenation? From the size of the lesions the latter would hardly be the answer. One may ask another question, does the growing neoplasm or the purulent lung disease cause an inflammatory reaction that calls for vascularization, oxygenation, and hemopoiesis and this process in turn result in a compensatory hyperplasia of the pituitary cells? This seems to be the logical explanation. The pituitary stimulates the development of the lung tissue. Not only do we see this in the human suffering from acromegaly and gigantism but it is also seen in the animal made acromegalic by crude pituitary beef extract as shown by Putnam, Benedict and Teel.[51] Their report on the lungs follows: "The lungs were engorged, purple and soft, but not crepitant; they sank in water. Pink foam could be squeezed from the bronchi and from the cut surface. In the control animal, the lungs were pink, dry and crepitant. There were no areas of consolidation in either animal. In the experimental animal, the lungs

weighed 545 gm.; in the control animal, 160 gm."

The microscopic report on the lungs read: "There was a congestive edema of the lungs of the treated animal. Most of the alveoli were filled with an amorphous protein precipitate containing a few red cells. A few were distended with air. There was no bronchitis, and no purulent or fibrinous inflammation. The capillaries were congested. By comparison the normal lung appeared particularly empty and delicate. There was no striking difference in the general size of the alveoli between the two lungs." They went on to say, "The factor of long-standing congestion must be taken into account in some of these organs, particularly the lungs, which were edematous, *but obviously cannot explain the full extent of the changes*. Of interest is the fact that there was great engorgement of vessels everywhere in the experimental dog. The weight of the heart was double that of the control dog."

Stockard and Vicari[61] studied the pituitary glands from 8 male and 6 female bulldogs. Microscopically, while they were not uniformly alike in detail, their general qualities were closely similar. The features were constant enough to enable one to distinguish the bulldog pituitary from that of the long muzzled breeds. The chromophilic proportions of high acidophilic and low basophilic cells were characteristic of the bulldog gland. There were more than thirty acidophilic cells to one basophilic.

Stockard and Johnson[60] in studying dogs, crossed various species, said that, "The one character common to all these breeds and hybrids in which structural misfits occur is an abnormality of the pituitary gland. Such an array of growth disharmonies in association with pituitary abnormality makes it seem highly probable that the pituitary secretions are largely concerned with the normal regulation and adjustment of growth among the organ systems and bodily parts. It should be remembered that many of these disharmonious arrangements are strictly inherited in very definite fashion. This fact may mean that the related peculiarity of the pituitary is the primarily inherited character, while the structural derangements are secondary results due to the failure in harmonious growth regulation by the genetically modified pituitary gland." It would seem most likely, therefore, that the inheritance factors carried in the genes would determine how a particular tissue or organ would develop in the uterus and post-fetal life, reacting to the pituitary secretion according to this inheritance factor. Thus one can understand the somewhat varying clinical picture seen at times in acromegaly and gigantism as well as in other pituitary diseases.

As Kenyon[30] said, while much is known of the pituitary relationship to the adrenal cortex, the reverse, that is, adrenal cortex changes followed by pituitary changes, is not. Some of the data relative to this have been given. That an adrenal cortex tumor with metastases to the lung may result in pituitary changes is shown in a brief summary of a case previously reported:[47]

A white laborer, aged sixty-three, had a left inguinal hernia repaired and a left hydrocele excised. A month later he returned complaining of vomiting and loss of weight. A hard irregular mass about 7 cm. in diameter, extending downward from the left costal margin, was present. Roentgenograms of the lungs showed evidence of pulmonary metastases.

The average values found in the patient's blood may be summarized as follows: red blood cells, 8,194,000; hemoglobin, 153 per cent; reticulocytes, 1.3 per cent; polymorphonuclears, 95 per cent; lymphocytes, 5 per cent, and white blood cells, 8,000.

At postmortem examination a large invasive tumor of the left kidney was found. This had metastasized to the lungs. Microscopically, the tumor was found to be a malignant angiomesothelioma with large pale staining cells. The structure was different from the ordinary type of Grawitz tumor and in some areas was markedly reminiscent of decidual tissue. The pituitary was not remarkable grossly but microscopically showed marked hypertrophy and hyperplasia of the basophil elements. The bone marrow showed marked myeloid hyperplasia throughout the marrow space.

Fig. 6. Massive portal thrombosis associated with polycythemia.

The embryonic type of tumor resembling decidual tissue, involving the adrenal cortex and metastasizing to the lungs, produced a pituitary basophil hyperplasia and a resulting polycythemia vera and a marked hyperhemoglobinemia.

Another case observed at Harper Hospital of polycythemia vera with pituitary basophil hyperplasia is reported, as follows:

M. S., white male, aged forty-five; height, 74 inches; weight, 220 pounds. Complained on admission to the hospital, January 5, 1945, of pruritus ani and rectal bleeding for one year. Treated for peptic ulcer four years ago. For the past eight months numbness and tingling of the left calf while sitting. Gave ten blood transfusion donations to the Red Cross before hemorrhoidectomy. Important findings at that time were: hemoglobin, 107 per cent; erythrocytes, 5,900,000; leukocytes, 10,900; differential count, normal. Had a hemorrhoidectomy, fissurectomy, sphincterotomy, and circumanal neurotomy and was discharged on January 10, 1945, Re-admitted January 17 for sudden severe lower abdominal pain. Patient was cold, clammy and in a state of collapse. The hemoglobin was 136 per cent, red blood cells 7,000,000, white blood cells 25,800, 86 per cent polymorphonuclears; nitrogen 77 mg. per 100 cc. of blood, icteric index 11, total protein 6.2. The abdominal distention became marked with some rigidity; the liver was palpable. He passed blood clots in the urine and he became cyanotic, irrational and died on January 25, 1945. Postmortem: The important findings on postmortem examination were a massive portal thrombosis (Fig. 6), thrombosis of the splenic vein (Fig. 7), and basophilia of the pituitary gland (Fig. 8). This relationship of the pituitary basophilia to the polycythemia is of importance and is further evidence that the basophil cell is related to erythropoiesis.

Adams and his associates[1] reported a case of hemangioma of the lung, with clubbing of the fingers and toes and generalized

Fig. 7. Thrombosis of the splenic vein associated with polycythemia.

cyanosis. The roentgenogram of the chest revealed a large, irregularly shaped, circunscribed opacity in the left lung and a small one in the right lung. There were associated compensatory polyemia, polycythemia and hyperhemoglobinemia. The authors said that on the basis of the pathologic picture the lesions are really arteriovenous aneurysms or fistulas. The pulmonary lesion produced a great compensatory change in the quality and the quantity of the blood. Polycythemia (7,200,000 red cells) was present before the operation and was reduced by this procedure. The microscopic study of the specimen removed from the lung revealed pulmonary tissue surrounding the three separate mesothelial lined cavities found in the left lung. The writers stated that the condition in others has probably gone undiagnosed and has been treated as polycythemia vera.

In view of the relationship of the pituitary to blood formation, the vascular system, and oxygenation, it is unfortunate that studies of the pituitary are not included as a routine in conditions involving these functions.

A close relationship exists between the lung with its capillary surface area, oxygenation, circulating blood volume, volume of respiratory exchange and the functions of the pituitary gland. Certain it is that if this gland is concerned with the formation of capillaries and the circulatory system and with hemopoiesis, then there must be an unquestioned interrelationship between lung function and the pituitary.

The proved fact that the pituitary is concerned with water exchange in the kidneys immediately suggests in view of the foregoing that it is also concerned with the insensible water loss of the lungs brought about by the water discharged through these organs. Respiration, as we know, involves a continuous loss of water from the body and as physiologists have shown the amount lost varies directly with the difference in temperature between the subject and his environmental air and inversely as the vapor pressure of the latter.

We are also acquainted with the fact that temperature regulation is a function of the hypothalamus, demonstrating the close physiological connection between the pituitary and hypothalamic functions.

The recent work on thiouracil and its effect on the thyroid and pituitary glands is of interest in the present discussion of growth. Griesbach[15] showed that rats treated with brassica seeds had changes in the pituitary consisting of a rapid increase in the basophilic cells and a decrease in the

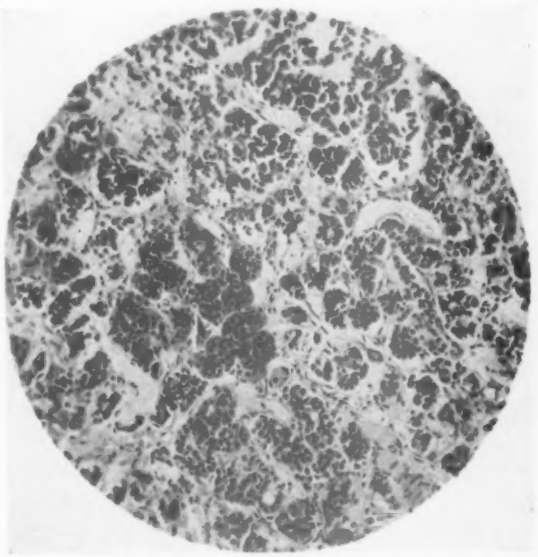

Fig. 8. Basophilia of the pituitary gland associated with polycythemia.

acidophilic. No goitrogenic effect was seen in rats previously subjected to hypophysectomy. He stated that this indicates that in order "to produce thyroid hyperplasia it requires the mediation of the thyrotropic hormone of the pituitary." The rate of growth was inhibited when young animals are fed thiouracil, thiourea and sulfonamide compounds. This is readily understood since the eosinophil cells are reduced in number. Furthermore, thiouracil inhibits the growth-promoting effects of anterior pituitary growth hormone injected into rats. Cretinism is produced in these animals by thiourea and thiouracil (Hughes[28]). The thyroid glands of the animals so treated show within a few days a distinct enlarge-

ment. Astwood and Bissell[2] found that seventy-two hours after thiouracil therapy was begun on rats there was a 60 per cent increase in weight of the thyroid gland. The enlarged thyroid glands were vascular, the cells being tall and columnar with a reduction in the colloid.

Sulfonamide compounds and thiourea produced changes in the pituitary gland. These were degranulation and decrease in number of acidophil vacuolation and increase in number and size of the basophils (MacKenzie and MacKenzie[40]). The effects were similar to those seen after thyroidectomy. It is interesting in this connection that Poos' experiments indicate that no matter which endocrine gland is removed the pituitary goes through four stages of reaction and if these changes are similar to those following thyroidectomy then one can understand that increased vascularity would be the result of the initial stage of physiological overactivity of the pituitary gland followed by the stage of degeneration. The increase in acidophils would account for the stage of increased vascularity.

If the eosinophil and basophil cells are reduced in function then it is readily understood why growth is inhibited and anemia of a severe degree may ensue even to the extent of agranulocytosis. No doubt the whole reticulo-endothelial system is depressed.

It is of interest and pertinent to the present discussion that Schittenhelm and Eisler[57,58] found that there was a local increase of thyroxin-iodine in the interbrain by the experimental exhibition of this latter substance when given to rabbits. These investigators injected rabbits intravenously for ten days; a daily dose of thyroxin equal to 1 mg. per kg. of body weight was given. The thyroxin had a selective action for the interbrain.

Sturm and Schneeberg[62] found after a single intravenous injection of thyroid and iodine feeding of rabbits values in the tuber cinerum of 260 gamma and 560 gamma of iodine and in the pituitary between 700 and 2,400 gamma of iodine. According to Lohr and Wilmanns[39] the various sections of the brain contain normally between 5 and 35 gamma of iodine. The human pituitary contains 60 gamma of iodine. This was the average of 24 pituitary glands. The highest values are, therefore, found in the pituitary and this coupled with the fact that pituitary tissue was the most active one in destroying thiouracil points to a certain common denominator in achieving benefits in thyroid disease when these drugs are administered.

Some of the benefits obtained by iodine are unquestionably due to its central action.

It is certain that many symptoms of thyrotoxicosis are due to central nervous system involvement. The benefits of iodine administration in this disease may therefore be similar to thiouracil in its action on the pituitary and interbrain.

The lessened response to thiouracil in patients who have received iodine may have an explanation in that the iodine is probably not so easily displaced in the pituitary and interbrain because of the affinity of these for iodine and the thiouracil by-passes the pituitary. In other words, there is a chemical affinity of the iodine for pituitary tissue.

Gordon, Goldsmith and Charipper[14] showed that feeding of thiourea or sulfadiazine to rats for fourteen or forty-five days caused a diminution in the quantity of thyroid-stimulating factor in the blood sera and pituitary glands as judged by the effects of such materials on the rate of metamorphosis of *Rana pipiens* larvae. Rats six months after thyroidectomy possess increased amounts of thyrotrophic hormone in their blood sera and hypophyses.

The above authors conclude that these materials depress the formation of active thyroid principle and cause an increased release of thyrotrophin from the pituitary into the blood, where, however, it appears in reduced amount because of its removal and increased utilization by the enlarging thyroid gland.

Rawson, Tannheimer and Peacock[56]

found that the average uptake of radioactive iodine by the control rat thyroids was 56 per cent of the administered tracer dose, that by thyroids of thiocyanate treated rats, 87 per cent and that by thiouracil treated rats, 10 per cent. These writers state that "it appears then that at least one action of this drug [thiouracil] on the function of the thyroid is to interfere with the iodinization of the thyroglobulin molecule, thus preventing the elaboration of any physiologically active hormone."

Astwood and Bissell[2] found that the administration of thiouracil to young rats was followed by a nearly complete disappearance of iodine from the thyroid glands in five days and a threefold increase in the size of the glands in two weeks. These effects were inhibited by hypophysectomy or by the injection of thyroxin. Injections of thyroxin or removal of the pituitary markedly retarded the accumulation of iodine.

Of importance are the anatomical effects of thiouracil. Williams, Weinglass, Bissell and Peters[67] studied the anatomical effects of thiouracil on rats and found among other things that thiouracil caused a distinct retardation in the rate of growth. It also tends to abolish the effects of growth hormone. The pituitary, adrenals and gonads of thiouracil treated animals were smaller than those of the siblings. A few animals showed a distinct leukopenia and anemia. Six patients who were given thiouracil for six to twenty-eight days preceding death were not found on postmortem examination to show any gross or microscopic effects of this drug.

To be valid, however, it would be necessary to study the pituitary glands of animals having agranulocytosis, but even in these rats the pituitaries were smaller and no doubt had a reduced function. As noted, some showed leukopenia and anemia.

Concerning the 6 human subjects, only 0.6 gm. daily was given for too short a time to draw any conclusions. The study of the pituitary gland in fatal agranulocytosis is necessary.

Certain immune mechanisms can be postulated as being at work. If the pituitary has a hemopoietic function, then whenever fever is present such as seen in infectious processes it is reasonable to assume that the latter sets the hypothalamic-pituitary mechanism in motion with resulting increased circulating blood volume, oxygenation and hemopoiesis including leukocytosis. It will be remembered that in Cushing's syndrome leukocytosis is present *without* infection, showing that the basophil cells play a part in the immune mechanism of the body.

One can also understand why severe or long standing infections by their toxemia may depress the pituitary function and lead to severe anemia and death.

Kraus and Traube[34] found the number of basophil cells reduced in individuals with asthenic habitus such as in tuberculous individuals and if these cells have anything to do with the immune mechanism it is logical to suppose that they would react poorly to infection. Understandable on this basis is the fact that a hypoplastic pituitary would react poorly to lung involvement or any infection.

A study of the immune mechanism reveals the fact that practically all the elements involved in immunity are derivatives of the mesoderm. The pituitary has a selective action on the mesoderm and if such is the case then hypoplasia of the pituitary during intrauterine life would result in an asthenic habitus with hypoplasia of the mesoderm.

Perla[52] concluded from his work that hypophysectomy is associated with a drop in natural resistance to spontaneous bacterial infections and to induced infections with a protozoan such as *Trypanosoma lewisi*. Decrease in resistance to such infections is in part due to atrophy of the spleen and lymphoid tissue of the body. Perla is of the opinion that the drop in natural resistance, particularly to poisons following the removal of the pituitary, is in part an expression of the insufficiency of the function of the suprarenal cortex, due to the withdrawal of the adrenotrophic hormone.

There has also been demonstrated a definite relationship of the pituitary to the spleen. Decrease in size of the spleen follows hypophysectomy. There is a progressive atrophy of the spleen following this operation (Perla).

White and Dougherty,[66] from their experimental work, stated that "The data lead to the conclusion that the lymphocytes of lymphoid tissue are a storehouse for a portion of the globulin fraction of the serum, and that the rate of release of this protein is under the normal physiological control of the pituitary adrenotrophic hormone which exerts its influence by way of the adrenal cortex. The evidence permits the integration of the functioning of the lymphocyte and the adrenal cortex in normal defense mechanisms of the organism."

In connection with the statement that the rate of release of globulin protein is under the control of the pituitary, the work of Leathem[37] becomes of interest. This worker found that a rise in total plasma protein concentration occurs in male rats fed 1 per cent thiourea for twenty to twenty-two days. This total protein rise is due entirely to an increase in plasma globulin, in that plasma albumin concentration does not change. Thus the blood protein changes simulate those observed after thyroidectomy.

A study of the literature emphasizes the importance of the pituitary to the immune mechanism of the body. It is logical to assume that the relationship of the pituitary to the development of the vascular system (including the capillaries), hemopoiesis, oxygenation and lung function places it in the front ranks of the factors controlling immunity. As previously stated, infection and any modality which induces fever will involve the hypopthalamic-hypophyseal system which activates the immune mechanism.

On certain occasions, though not too frequently, hyperpituitarism in the form of acromegaly or gigantism may follow a long standing infection such as typhoid fever. On the other hand, clinicians frequently see rapid growth in youthful individuals following an acute infection such as scarlet fever and measles. Presumably the infection activates the pituitary.

Furthermore, it is well known that the sulfonamide compounds including thiourea and thiouracil produce fever and it is reasonable to suppose it is due to the toxic effect on the hypothalamic-hypophyseal mechanism. Occasionally, as reported by Cargill and Lesses,[7] submaxillary gland swelling follows the administration of thiouracil. This, we believe, is due to the changes in the thyroid for it has been shown that the thyroid is essential to the development of the salivary glands (Hammett[16]).

It is interesting that iodides not infrequently cause swelling of the submaxillary glands as well as salivation.

F. D. Dodrill and I are reporting the results of our experiments on dogs showing the reciprocal relationship between lung function and the pituitary gland. Dogs normally have a polycythemia (6 to 7 million red cells per 100 cc.) compared to humans. These animals do not have sweat glands and the rapid oxygen exchange with panting explains why they normally have a comparative polycythemia as compared to humans. They also have large spleens.

SUMMARY

Clinical evidence has been presented to show that the pituitary gland produces growth by the formation of the mesodermal vascular system and by supplying blood to the tissues. The production of localized acromegaly or gigantism has been seen in arteriovenous fistula of an extremity showing that it is by an increase in the vascular development with consequent increase in blood supply that growth takes place. In this instance there is no generalized increase of pituitary function but this example illustrates that growth may be produced by such conditions without the presence of a specialized growth hormone. *If one accepts the hypothesis that the pituitary gland in-*

duces growth by developing the circulatory system of the body and hemopoiesis, then there is no need to assume the presence of the so-called specific hormones or polyhormones since all endocrine glands would be affected by this mechanism as well as the body as a whole.

Congenital hypopituitarism results in a defective development of the vascular system with a decrease in blood supply to the tissues resulting in dwarfism.

The dwarfism of cretinism is the result of pituitary underfunction with lack of capillary development.

This same holds true for all forms of dwarfism and is responsible for the changes seen in anencephalic fetuses and renal rickets in which defective development of the pituitary is found.

A close relationship exists between the eosinophil and basophil cell of the pituitary; the former probably is responsible for vascular development and the latter for hemopoiesis.

On the basis that the chromophil cells control vascular development and hemopoiesis, and the posterior lobe has a vasoconstrictor effect on the capillaries, an explanation was offered for the phenomenon of menstruation. The menstrual function is postulated as being brought about by the activity of the anterior lobe chromophil cells producing the development of the endometrial capillaries and the endometrial blood, mediated by the synergistic estrogenic hormone with a chemical interplay between the former and the latter and then followed by the development of the corpus luteum with the antagonistic progestational hormone which holds the posterior pituitary lobe in check so that the secretory nidational endometrium is formed. If no gestation has taken place the corpus luteum degenerates, the posterior lobe hormone acts as a vasoconstrictor on the capillaries and produces necrosis and anoxia of the endometrium with consequent shedding and the phenomenon of uterine bleeding per vagina.

Primary disease of the lungs, such as cancer (primary and metastatic), and chronic suppuration of the lung, and chronic pulmonary osteoarthropathy are often associated with pituitary chromophil hyperplasia.

It was suggested that the lung disease produced an inflammatory reaction which called for vascularization, oxygenation and hemopoiesis and this process in turn results in a compensatory hyperplasia of the pituitary chromophil cells. The pituitary has been shown to produce growth of lung tissue.

Hyperactivity of the pituitary has been found in patients suffering from cancer.

A close relationship exists between the posterior pituitary lobe and the vascular system as shown by its pharmacologic effect.

Sulfonamide compounds, such as thiouracil and thiourea, produce a reduction in the number of acidophils and an increase in the basophils and it was therefore suggested that growth was inhibited by the decrease of the former cells and the vascularity increased by the latter.

Iodine has been shown to have a selective action for the interbrain and pituitary and the benefits of this form of therapy may be due to its affinity for these tissues. The slower response of iodine treated patients to thiouracil may be due to the chemical affinity the pituitary and interbrain tissues have for iodine so that this substance is not readily displaced. The pituitary and lung function are intimately related on the basis of hemopoiesis, oxygenation, and water exchange. This gland as well as the hypothalamic region is probably involved in the immune mechanism of the body, and the rapid growth in children which frequently follows infectious diseases is due to the activation of the pituitary mechanism which has been set in motion by the toxemia.

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AN ANALYSIS OF THE PHYSICAL FACTORS CONTROLLING THE DIAGNOSTIC QUALITY OF ROENTGEN IMAGES*

PART I. INTRODUCTION

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THE diagnostic information which may be obtained from a roentgenographic film or roentgenoscopic screen is mainly determined by the clarity or detail with which the various roentgen images are visualized. It is therefore important that one be cognizant of the several factors which control roentgen detail and clearly understand their interrelationship. Such knowledge will greatly facilitate the choice of roentgen procedures with which optimal film and screen interpretability may be achieved. Furthermore, if sufficient quantitative data be provided, one may easily evaluate the relative merits of the various roentgen methods and materials available today.

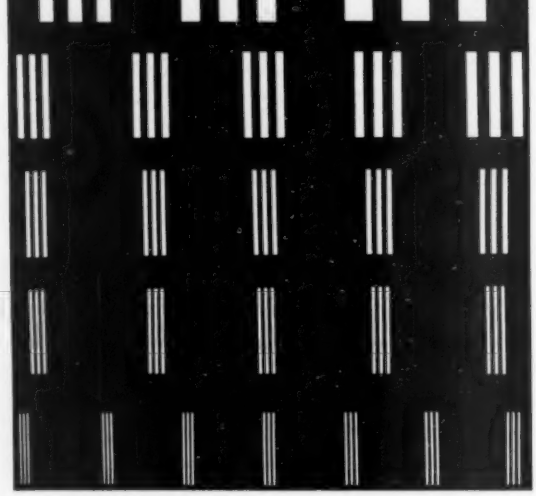

FIG. 1. Line drawing test object with which the resolving powers of photographic film may be tested.

Although the factors which control roentgen detail are generally understood, little has been written to indicate the manner in which they affect one another. In addition, a perusal of the literature reveals practically no quantitative data which are directly applicable to the solution of roentgen technical problems. It is not surprising, therefore, that opinions regarding many roentgen procedures vary between wide limits. For instance, there are many radiologists who are confident that there is an optimal kilovoltage at which each anatomical structure should be roentgenographed; others are equally certain that within reasonable limits the diagnostic quality of a roentgenogram is essentially unaffected by the kilovoltage used. A long list of similar examples could be cited. Because of this confusion a comprehensive analysis of the factors affecting the diagnostic quality of roentgen images has been undertaken and will be reported in this series of articles. It is hoped that the material to be presented will effectively clarify many perplexing problems in the field of technical roentgenology.

The clarity with which an image is recorded by a photosensitive material is a direct function of the ability of the material to record detail. This ability to record detail is customarily specified in terms of resolving power and, in photography, is measured by photographing on the film under test a line drawing similar to that

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illustrated in Figure 1. Under most circumstances films exhibit little difficulty in reproducing the coarser patterns. As one progresses to the finer configurations, however, a pattern is eventually encountered which the photographic emulsion can no longer resolve and the resultant image appears as a homogeneous opacity. The maximum number of lines per millimeter which the film can record represents the film's resolving power. The resolving powers of photographic films vary through a relatively wide range. Eastman Super XX film has a resolving power, for example, of 50 lines per millimeter whereas Eastman Microfile film has a resolving power of 130 lines per millimeter. The ability of the latter emulsion to record detail, therefore, is almost three times greater than the former.

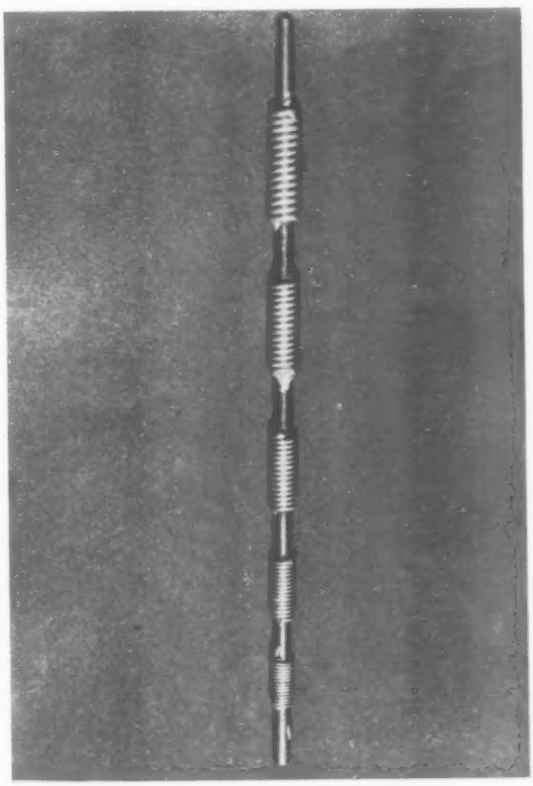

Fig. 2*a*. Wire-wound test object with which the resolving powers of roentgenographic films, intensifying screens and fluoroscopic screens may be measured.

Fig. 2*b*. Pattern produced by wire-wound test object on roentgenographic film.

Methods for measuring the resolving powers of photographic materials[1] have become well standardized. No such order exists however in the measurement of the resolution of roentgenographic films and screens. Indeed a satisfactory method for determining the resolving powers of roentgen materials has only recently been devised. The method[2] consists of roentgenographing on the film or film-screen combination under test, a mandril on which is wound a series of wires ranging in size from very fine to very coarse. A portion of such a test object is illustrated in Figure 2*a*. As shown in Figure 2*b*, the object produces on the film a series of serrated patterns, the coarser of which the film has little difficulty in recording. As the finer configurations are approached, a pattern is eventually reached which the film is unable to resolve and the image appears

as a uniformly straight line. The maximum number of serrations per millimeter which can be clearly seen in a film constitutes the film's resolving power. A more detailed description of the method together with quantitative data on many commercially available films and film-screen combinations will be presented in Part II of this series.

The resolving power of a photosensitive material is markedly influenced by the contrast* exhibited between a recorded image and its surrounding field. This relationship is illustrated graphically in Figure 3. There it is seen that when contrast is zero, resolving power also is zero; that is, no detail can be detected under these circumstances. When contrast increases, resolving power also increases, quickly at first, then less rapidly until finally a level is reached beyond which resolving power remains relatively constant. Photographic experiments[3] indicate that this relationship is in general an exponential one† and may be expressed by the equation

$$R = R_m(1 - e^{-aC}) \qquad (1a)$$

where R is the resolving power at a level of contrast, C,

R_m is the maximum resolving power of the material

a is a constant, which may be conveniently called the resolution coefficient and

e is the Naperian base.

For images of low contrast, the relation-

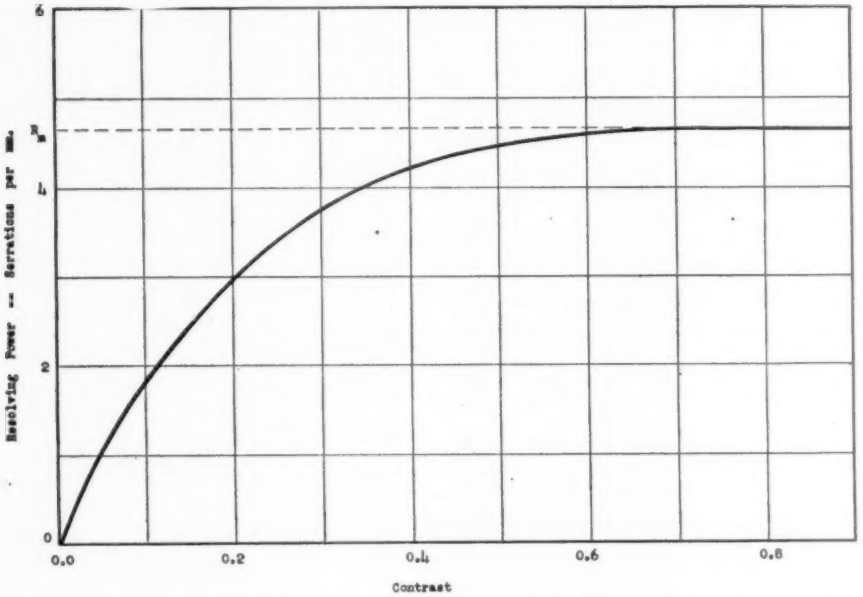

FIG. 3. Relationship between resolving power of a roentgen material and the contrast exhibited between a recorded image and its surrounding field.

* Quantitatively, the term, contrast, as used herein is defined as the difference between the logarithm of the light intensity emergent from a roentgen image and the logarithm of the light intensity emergent from the image's surrounding field; that is,

$$C = \log I_i - \log I_b \qquad (a)$$

where I_i is the intensity of the light emergent from the image and I_b is the intensity of the light emergent from the surrounding field.

Equation (a) applies to images appearing in both roentgenographic films and roentgenoscopic screens. Since the density of a roentgenographic film, according to standard definition, is equal to the logarithm of the light intensity incident on the rear face of the film minus the logarithm of the light intensity transmitted by the film (i.e., Density = $\log I_a - \log I_c$, where I_a and I_c are the incident and transmitted light intensities respectively), the contrast of a uniformly illuminated roentgenographic image may be expressed by the equation

$$C_f = D_b - D_i \qquad (b)$$

where C_f is roentgenographic contrast

D_b is the density of the film surrounding the image and

D_i is the density of the image.

† Recent experimental evidence indicates that a similar relationship obtains for roentgen materials.

ship may be more simply expressed by the equation

$$R = R_m a C. \qquad (1b)$$

The value of a photosensitive material's maximum resolving power, R_m, is governed by inherent properties, such as graininess and turbidity, of the material. In the case of roentgenographic films it is also a function of image-density, developing conditions and several minor parameters. A roentgen material's maximum resolving power may be measured by means of the wire-wound test object previously described. Care must be taken of course to insure that the image produced on the film or screen exhibits a high degree of contrast.

The value of the resolution coefficient, a, is also governed in part by inherent properties of the photosensitive material. Unlike the factor, R_m, however, this coefficient has an essentially constant value for a large variety of roentgenographic films and screens.

The dependence of resolving power on contrast is particularly significant because it establishes a relationship between roentgen technique and roentgen detail. The following analysis will make this more clearly evident.

When a roentgen beam is projected through a structure, the intensity of the emergent radiation in a plane normal to the beam varies from point to point depending on the absorption which the radiation undergoes within the various portions of the structure. The emergent beam therefore presents a series of roentgen-ray images of the several components included within the structure.

The intensity of the emergent radiation at any point in the image plane is a function of a large number of variables including the thicknesses, densities and atomic numbers of the materials transmitting the radiation, the intensity of the radiation emitted by the roentgen tube and the voltage applied to the roentgen tube. Portal dimensions and filtration (including a grid, if used) also are controlling factors. The relationship between roentgen-ray intensity and the thickness and density of a homogeneous material is illustrated graphically in Figure 4. This relationship may be expressed by the equation

$$\log G = \log G_0 - \int b\rho dx \qquad (2)$$

where G is the intensity of the radiation transmitted by the material,

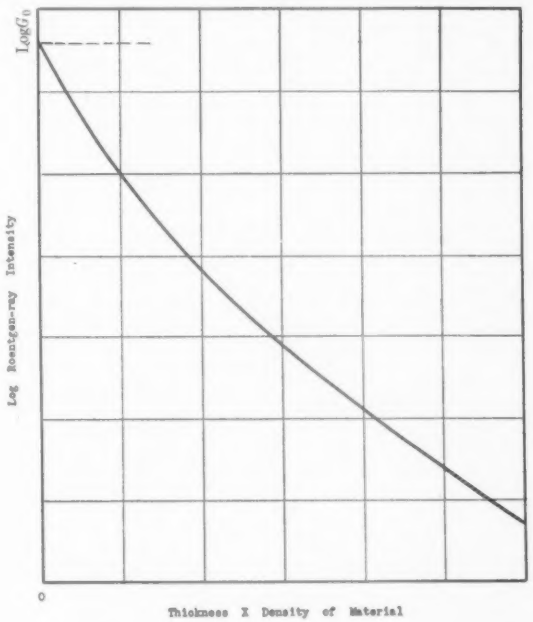

Fig. 4. Relationship between roentgen-ray intensity transmitted by a homogeneous material and the thickness and density of the material.

G_0 is the radiation intensity if no structure were interposed in the roentgen beam,

ρ and x are the density and thickness of the material respectively and

b is the negative slope of the log G vs. ρx curve.

The factor, b, is the material's mass absorption coefficient expressed in decadic logarithms. Its value is a function of the atomic numbers of the several components comprising the material and of the spectral distribution of the roentgen radiation. It thereby is a function of the voltage applied to the roentgen tube and of any filtration placed in the roentgen beam.

Equation (2) is valid only for a homogeneous structure. When the structure is heterogeneous (as is almost always the case) it may be easily shown that the equation should be written

$$\log G = \log G_0 - \int_0^{x_1} b_1\rho_1 dx - \int_0^{x_2} b_2\rho_2 dx \cdots - \int_0^{x_n} b_n\rho_n dx \qquad (3)$$

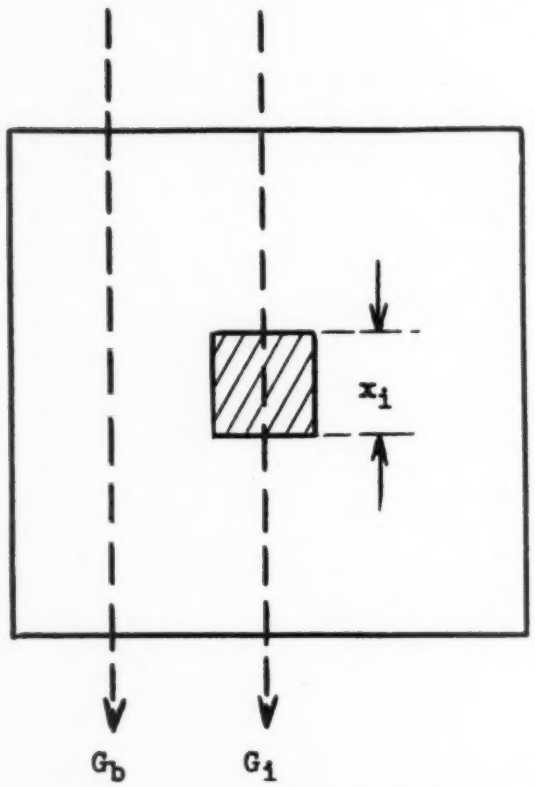

Fig. 5. Schematic diagram illustrating roentgen-ray intensities emergent from a structure below an included image-producing object (G_i) and elsewhere below the structure (G_b).

where the subscripts define the absorption coefficients, densities and thicknesses of the n materials included in the structure.

Now if a roentgen beam is projected through a heterogeneous structure which includes an image-producing object of thickness, x_i, and density, ρ_i, and having a mass absorption coefficient, b_i, the roentgen-ray intensity of the emergent beam directly below the object (see Fig. 5) is given by the equation

$$\log G_i = \log G_0 - \int_0^{x_1} b_1\rho_1 dx - \int_0^{x_2} b_2\rho_2 dx \cdots - \int_0^{x_i} b_i\rho_i dx \cdots - \int_0^{x_n} b_n\rho_n dx. \qquad (3a)$$

Also if this object is surrounded by material having a density, ρ_b, and a mass absorption coefficient, b_b, the roentgen-ray intensity of the emergent beam just outside the object's image is

$$\log G_b = \log G_0 - \int_0^{x_1} b_1\rho_1 dx - \int_0^{x_2} b_2\rho_2 dx \cdots - \int_0^{x_i} b_b\rho_b dx \cdots - \int_0^{x_n} b_n\rho_n dx. \qquad (3b)$$

When equation (3b) is subtracted from equation (3a)*

$$\log G_i - \log G_b = \int_0^{x_i} b_b\rho_b dx - \int_0^{x_i} b_i\rho_i dx. \qquad (4)$$

Under most roentgen conditions, the thickness of an image-producing object is sufficiently small that the values of the mass absorption coefficients remain essentially constant over the integral. Under these circumstances, therefore, equation (4) becomes

$$\log G_i - \log G_b = (b_b\rho_b - b_i\rho_i)x_i. \qquad (4a)$$

Now when roentgen radiation impinges on a roentgenoscopic screen, fluorescent light is emitted and the intensity or brightness of the fluorescence is directly proportional to the intensity of the exposing radiation; that is

$$I = kG \qquad (5)$$

where I is the light emission of the screen

G is the intensity of the roentgen radiation and

k is a constant.

* Since values of b are a function of the spectral distribution of the radiation, the terms which follow $-\int_0^{x_i} b_i\rho_i dx$ in equation (3a) are not exactly equal to those which follow $-\int_0^{x_i} b_b\rho_b dx$ in equation (3b) because the radiation passing through the object will be changed in quality somewhat differently than that transmitted by the surrounding material. This difference however is seldom likely to be large and accordingly in the derivation of equation (4) the two series of terms are considered equal.

Therefore when equations (4a) and (5) are combined,

$$\log I_i - \log I_b = (b_b\rho_b - b_i\rho_i)x_i \qquad (6)$$

where I_i and I_b are the light intensities emitted by the screen in the image and in the surround respectively.

But $\log I_i - \log I_b$ is the contrast exhibited by the image.
Therefore,

$$C_r = (b_b\rho_b - b_i\rho_i)x_i \qquad (6a)$$

where C_r is roentgenoscopic contrast.

If the roentgen radiation is permitted to fall on a roentgenographic film or film-screen combination instead of a roentgenoscopic screen, the density of the processed film will be a function of the quantity of radiation (usually referred to as the exposure) received by the film. This relationship is shown graphically in Figure 6 and may be expressed by the equation

$$D = \int g d \log E + K \qquad (7)$$

where g is the slope of the density vs. log E curve,

E is the quantity of radiation received by the film and

K is a constant.

The value of the factor, g, is governed by inherent characteristics of the film and the conditions under which the film is developed. Through the small ranges of density which usually occur between roentgen images and their surrounding fields, it remains essentially constant and for these conditions equation (7) reduces simply to

$$D = g(\log E - i) \qquad (7a)$$

where i is a constant (see Fig. 6). Now the quantity of radiation received by a photosensitive material is equal to the product of the effective radiation intensity, G, and the exposure time, t; that is

$$E = Gt. \qquad (8)$$

Therefore, equation (7a) may be written

$$D = g(\log G + \log t - i). \qquad (9)$$

When equation (9) is substituted in equation (4a) and terms in G are eliminated

$$D_i - D_b - g(\log t_i - \log t_b) = g(b_b\rho_b - b_i\rho_i)x_i \qquad (10)$$

where D_i and D_b are the densities of the film within the image and the surround respectively and t_i and t_b are the exposure times with which these densities were produced. However, all parts of the film receive the same exposure time. Therefore $t_i = t_b$ and equation (10) reduces to

$$D_i - D_b = g(b_b\rho_b - b_i\rho_i)x_i. \qquad (10a)$$

Now $D_i - D_b$ is the roentgenographic contrast exhibited by the image. Accordingly

$$C_f = g(b_b\rho_b - b_i\rho_i)x_i \qquad (10b)$$

where C_f is roentgenographic contrast. It is noteworthy that equation (10b) is also

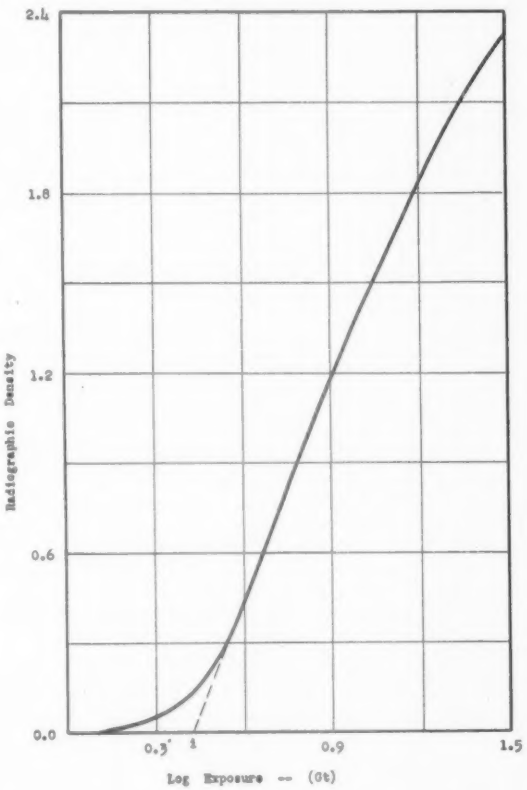

Fig. 6. Relationship between the density (photographic) of a roentgenographic film and the quantity of radiation (exposure) received by the film.

valid for roentgenoscopic contrast (equation (6a)) if a value of unity is assigned to g.

In the derivation of equation (10b) the influence of scattered radiation arising within the structure under examination was neglected. This phase of the subject however will receive extensive treatment in a later article. For the time being it will suffice to say that when scattered radiation is present equation (10b) should be written

$$C_f = g(b_b\rho_b - b_i\rho_i)\left(\frac{G_{ip}}{G_{ip}+G_{is}}\right)x_i \qquad (11)$$

where G_{ip} is the intensity of the primary roentgen radiation and

G_{is} is the intensity of the scattered radiation within the image boundaries respectively.

Equation (11) specifies contrast as a function of the thickness and density of an image-producing structure and of the intensities of the primary and scattered radiation. Also, through the mass absorption coefficients, b_i and b_b it specifies contrast as a function of the voltage applied to the roentgen tube, of the filtration in the roentgen beam, of the atomic composition of the image-producing structure and of its surrounding material, and of the type of roentgen material on which the radiation impinges (film, film-screen combination or roentgenoscopic screen). The dependence of contrast on roentgen technical factors is clear. In view of the relationship which exists between resolving power and contrast (equations (1a) and (1b)) it is evident that roentgen detail is closely related to roentgen technique.

In addition to contrast, resolving power is a function of the unsharpness with which a roentgen image is recorded. Due to the finite size of the silver halide grains in roentgenographic emulsions and of the fluorescent particles in intensifying and roentgenoscopic screens, the borders of a roentgen image are not perfectly sharp; that is, the transition in density or illumination at the image boundary is not abrupt but instead tends to be gradual. This inherent unsharpness may be accentuated by movement of the structure under examination or by an excessively large target in the roentgen tube. Under certain circumstances such an increase in unsharpness may materially reduce the resolving power of a screen or film and accordingly efforts should be made to reduce target size and anatomical motion to a minimum.

In general, resolving power is an inverse function of unsharpness; that is,

$$R = \frac{m}{U} \qquad (12)$$

where m is a proportionality constant and U is unsharpness. It is evident from equation (12) that if R_e is the resolving power of a material under conditions when extraneous factors producing unsharpness (target size and anatomical movement) are present and R_a is the material's resolving power under conditions in which resolution is limited only by inherent unsharpness,

$$R_e = R_a(U_i/U_t) \qquad (13)$$

where U_i is inherent film or screen unsharpness and

U_t is overall unsharpness (inherent and extraneous unsharpness collectively).
That is, extraneous unsharpness reduces resolving power by a factor U_i/U_t.

From the foregoing it is clear that equations (1a) and (1b) to be more generally applicable should be written

$$R = R_m(1-e^{-aC})(U_i/U_t) \qquad (14a)$$

and

$$R = R_m aC(U_i/U_t) \qquad (14b)$$

where

$$C = g(b_b\rho_b - b_i\rho_i)\left(\frac{G_{ip}}{G_{ip}+G_{is}}\right)x_i.$$

Equations (14a) and (14b) are of fundamental importance for they establish a direct quantitative relationship between roentgen detail and the many factors upon which roentgen detail is dependent. If sufficient data be available, they permit an unequivocal comparison of the merits of

various roentgen procedures such as photofluorography versus general roentgenography, low kilovoltage technique versus high kilovoltage technique and small target size versus large target size. In forthcoming publications of this series, quantitative data on each of the factors appearing in these equations will be given. In Part II methods for measuring the maximum resolving power, R_m, and the resolution coefficient, a, of roentgen materials will be described. Data on a variety of films and screens will be included in this report.

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EBSTEIN TYPE OF TRICUSPID INSUFFICIENCY*

ROENTGEN STUDIES IN A CASE WITH SUDDEN DEATH AT THE AGE OF TWENTY-SEVEN

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TRICUSPID insufficiency is infrequently diagnosed clinically. A study at New Orleans indicated that only 1 case in 30 is recognized.[12] Congenital tricuspid insufficiency of the Ebstein type has been reported only 16 times and has apparently never been diagnosed before postmortem examination. In most cases of tricuspid insufficiency the expectancy of life is considerably shortened. The average age at death in Ebstein's disease is twenty-five years. Two individuals lived to be sixty; 4 others lived beyond the age of thirty. The causes of death are shown in Table 1. The incidence of sudden death seems to be rather high, but the series is too small for conclusions to be drawn. Nevertheless it is interesting to consider a fourth case with sudden death, followed over a period of nine years, the seventeenth case to be reported.

CASE REPORT

The patient was first seen when she was eighteen years old. She complained of weakness, easy fatigability and breathlessness in response to minor exertion. The most distressing symptom was "heart flutter." She was one of three children. No history of heart disease in her family could be elicited. From the age of six this girl had suffered palpitation and shortness of breath on exertion. No precordial pain, cough, sputum, edema or cyanosis had bothered her. Menses began at thirteen and were always regular. Intermittent attacks of severe palpitation, lasting many hours, had recently begun, with onset following excitement. Quinidine therapy afforded relief for these attacks of paroxysmal tachycardia.

TABLE I

CAUSE OF DEATH IN REPORTED CASES

Date	Author		Sex	Age	Cause of Death
1866	Ebstein		M	19	Tuberculosis and congestive failure
1886	Marxsen		F	61	Ulcerative colitis
1900	MacCallum		M	30	Pulmonary tuberculosis
1903	Schönenberger		F	4.5	Sudden death
1903	Geipel	Case I	M	18	Not stated
		Case II	?	15	Not stated
		Case III	M	15	Cerebral embolus
1908	Malan		M	60	Mesenteric thrombosis
1913	Heigel	Case I	F	10	Meningitis
		Case II	F	3	Bronchopneumonia
		Case III	F	38	Cord paralysis
1919	Blackhall-Morison and Shaw		M	38	Tuberculosis; meningitis
1922	Blackhall-Morison		M	33	Sudden death (no previous ill health)
1927	Arnstein		F	20	Tuberculosis
1928	Abbott		M	16	Erysipelas
1938	Yater and Shapiro		F	21	Sudden death
1944	Bauer		F	27	Sudden death

Statistics: 8 M, 8 F, 1 unknown; average age, 25.2 years.

* From the Department of Radiology and the Department of Pathology of Duke University School of Medicine and Duke Hospital, Durham, North Carolina.

The patient weighed 55.5 kg. and was 166 cm. tall. She was not jaundiced nor cyanotic. There was no clubbing and the neck veins were not distended. A marked precordial heave was evident; but a true seesaw movement of the chest wall was not present (absence of outthrust over the liver). A systolic thrill was palpable over the apex. In the same area could be heard systolic and mid-diastolic murmurs. The murmur of systole was audible over the entire precordium but it was maximal in the fourth left interspace at the sternal border. The lungs were clear. The liver could not be felt. The pulse rate was 75. The electrocardiogram showed normal sinus rhythm and bundle branch block.

Roentgenoscopy and roentgenography of the chest showed marked enlargement of the heart in all diameters. Pulsations were rapid and strong. The aorta did not appear dilated. The right cardiac margin, composed probably of the right atrium, projected to the right and posteriorly. Measurements were: midline to the right border, 7.5 cm.; midline to the left border, 11 cm.; great vessels, 4.6 cm.; transverse diameter of the chest, 24 cm.

The patient was not admitted to the hospital, but was seen several times in the outpatient clinic, up to the time of an attack of "rheumatism" at the age of twenty. Thorough examination at that time disclosed that her "rheumatism" was an acute gonococcal arthritis involving the right wrist. Since the previous study, she had lost 4 kg. and was 7 kg. below ideal weight for her height and age. Bouts of palpitation and dyspnea on exertion were less troublesome because she had learned to accept her physical limitation and was leading a less active life. There was no clubbing, jaundice, dyspnea, distention of neck veins or pulmonary congestion. One experienced observer noted slight cyanosis (but this may have been related to chemotherapy).

Teleroentgenograms and roentgenoscopy showed increase of the transverse diameter of the heart since the previous examination (two years before). Measurements now were: midline to the right border, 8 cm.; midline to the left border, 11.5 cm.; great vessels, 4.3 cm.; transverse diameter of the chest, 25 cm. The enlargement seemed to be largely confined to the right side of the heart. The electrocardiogram showed normal sinus rhythm at a rate of 88. Right bundle branch block was noted. The impression of most observers was that the patient had some form of complicated congenital cardiac malformation, possibly tetralogy of Fallot.

At the age of twenty-seven the patient was admitted again, for study of her cardiac status and consideration of the advisability of oophorocystectomy. For the past five years she had noticed a slowly growing abdominal mass which the gynecologists believed to be a benign ovarian cyst. The patient complained of dyspnea on climbing stairs (even very slowly) and she limited her activities carefully to prevent unpleasant manifestations of her cardiac insufficiency. Attacks of paroxysmal tachycardia were very infrequent; minor episodes of palpitation were always related to physical exertion, worry or excitement. She weighed 60.6 kg., a gain of 9.3 kg. since the last admission. Consequently she was up to the average weight for her height and age. There was no cyanosis, clubbing, jaundice, distention of neck veins, orthopnea or pulmonary congestion. The apical systolic thrill was present as before. At the apex and in the third, fourth and fifth left interspaces parasternally there was a loud, low-pitched, rough systolic murmur synchronous with the thrill. An early diastolic murmur was heard only in the fourth and fifth left interspaces parasternally. The liver was not palpable. The blood pressure was 105 systolic and 80 diastolic.

The electrocardiogram showed the same general picture as previously, with normal sinus rhythm and right bundle branch block. The heart rate was 77. Roentgenogram of the chest demonstrated rapid, feeble pulsations and marked enlargement of the right atrium and ventricle. The heart measurements were: midline to the right border, 9 cm.; midline to the left border, 12 cm.; great vessels, 5 cm.; transverse diameter of the chest, 25 cm. The kymogram showed rapid, irregular pulsations, suggesting fibrillation or myocardial degeneration. The heart was larger in all diameters than at the examinations nine and seven years previously and the increase was chiefly right sided.

Oophorocystectomy was performed under spinal anesthesia. A papillary cystadenoma of the ovary was removed. The postoperative course was entirely satisfactory and the patient was discharged on the twelfth postoperative day. She returned for dressings on the twenty-first and twenty-eight postoperative days. She

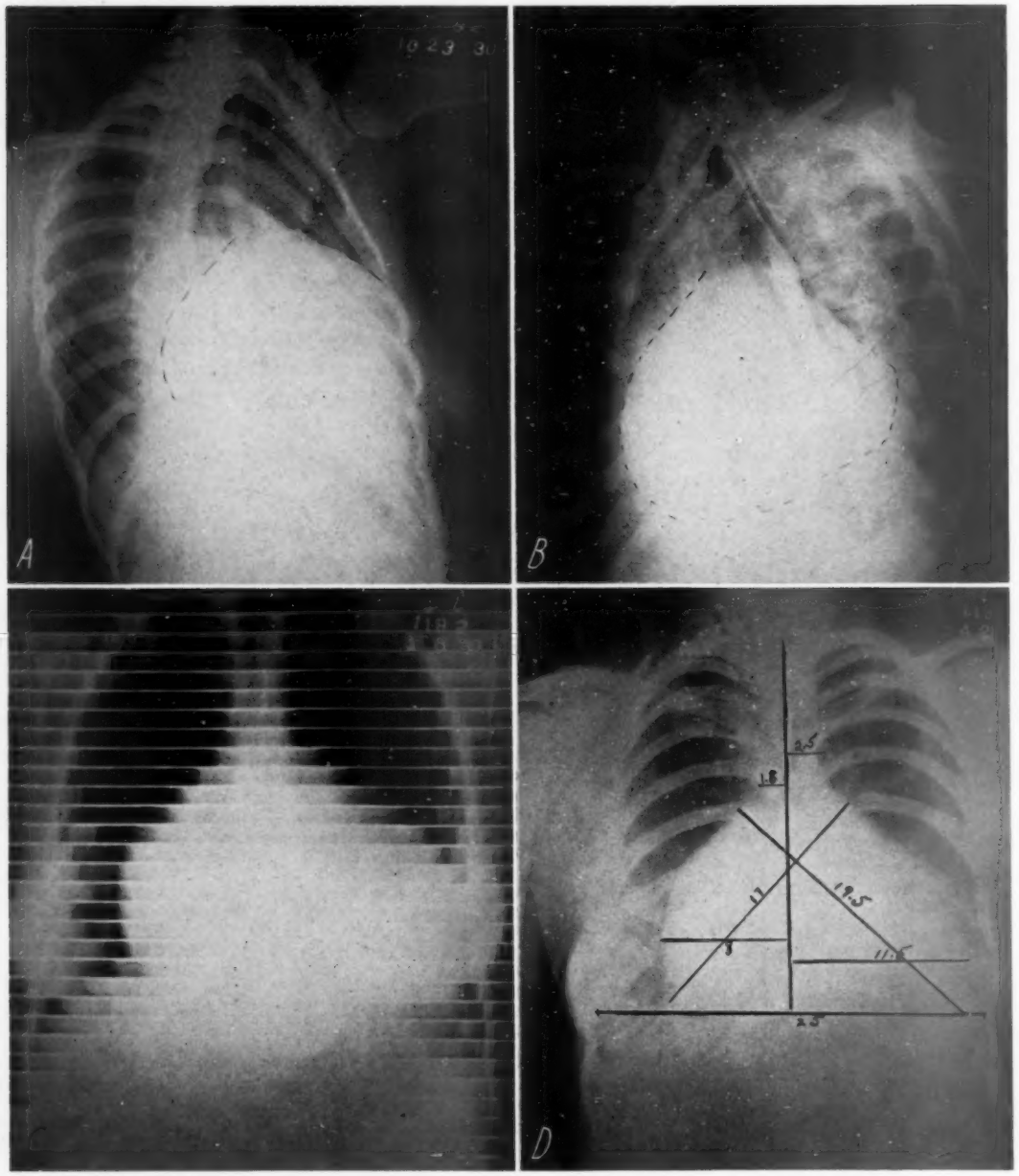

Fig. 1. *A*, right anterior oblique view at the age of eighteen, showing enlargement of the right atrium. *B*, left anterior oblique view at the age of twenty, showing the huge right heart without esophageal displacement. *C*, kymogram at the age of twenty-seven, showing feeble pulsations and irregularity. *D*, posteroanterior view at the age of twenty, with cardiac measurements.

died suddenly during the latter clinic visit. While arranging her clothes after climbing down from the examining table, she cried out for help. She was found leaning against the examining table and she was cyanotic with cool, moist skin. Her color improved when she had been lifted back to a supine position on the table; but she tossed from side to side and conversed in garbled, incoherent speech. Tachypnea was evident, but not orthopnea. Oxygen and carbon dioxide were administered but respirations ceased. Artificial respirations and intracardiac

coramine were without avail. The attending physicians believed death was caused by pulmonary embolism.

Autopsy. The right hand and forearm (involved seven years ago in gonococcal arthritis) are atrophic. The peritoneal cavity contains about 200 cc. of clear liquid. Each pleural cavity contains about 50 cc. of clear liquid. The pericardial sac is fluctuant and distended with 500 cc. of blood-colored, unclotted liquid. Pericardial surfaces are not smooth but have many minute, wart-like excrescences and some short, fibrous strands. No evidence of myocardial perforation, coronary rupture or pulmonary emboli is found. The heart weight, 470 gm., is approximately 200 gm. more than the average for a woman of this age. It is a huge heart with striking predominance of right-sided enlargement. The left atrium measures 5 by 5 cm. There is no atrial rheumatic patch. The foramen ovale is patent to the probe. The mitral valve is 7 cm. in circumference. Its free margin is definitely thickened, and some of the chordae tendineae are thickened but not shortened. The valve appears competent and not stenosed. The left ventricle measures 9 by 4 cm. Its wall is about 12 mm. in thickness. There is no ventricular septal defect. The aortic valve circumference is 5.5 cm. This valve is not thickened, but is well formed, smooth and delicate. The aorta beyond is neither stenosed nor dilated. The ligamentum arteriosum has replaced the ductus arteriosus.

The right atrium measures 5.5 by 8 cm. and is obviously dilated and hypertrophied. The coronary sinus is greatly dilated. The right atrioventricular orifice measures 21 cm. in circumference. This, however, is not the line of attachment of the insufficient tricuspid valve. The total circumference of the line of attachment is 30 cm. The anterior cusp is properly attached at the atrioventricular sulcus. The left or septal half of the posterior cusp is attached to the sulcus, but the remainder of the posterior cusp is attached to the ventricular wall in a curved line which sweeps progressively downward to the posteroseptal commissure. The septal cusp, beginning at the anteroseptal commissure, likewise attaches to the ventricular wall in a downward sweep with a maximum departure of 8 cm. from the atrioventricular sulcus. The papillary muscles, almost insignificantly small structures, are hardly distinguishable from columnae carneae. This is particularly true because the chordae tendineae are extremely short, thus effectively binding the valve leaflets to the ventricular walls and making the valve totally insufficient. The moderator band is clearly discernible. The right ventricle measures 12 by 12 cm. The normal appearing pulmonary valve measures 6.5 cm. in circumference. The artery beyond is neither stenosed nor dilated, but is uniformly, slightly smaller in caliber than usual.

Microscopic examination of the pericardial excrescences shows a chronic type of pericarditis with fibrous thickening, numerous lymphocytes and many iron-holding macrophages. The myocardium is not scarred; no Aschoff bodies are found. The thickened portions of the mitral valve show a few round cells but no vascularization or definitive changes. All the viscera show evidence of acute congestion. There is no central necrosis in the liver, but there is some periportal fibrosis with moderate round cell infiltration.

Postmortem Roentgen Studies. Additional roentgenograms were taken of the heart specimen in an attempt to obtain further information of value for the interpretation of the antemortem teleroentgenograms. Factors used were: 72 inches, 20 ma., 35 kv., and 2½ seconds. By means of diaphragms sewn into the specimen at the true atrioventricular orifice and at the actual line of attachment of the tricuspid valve, it was possible to visualize separate portions of the right side of the heart with barium. The illustrations include anteroposterior and right-left views of the heart under these conditions.

The barium-filled right atrium is shown in Figure 2. Evidently the upper border of the right auricular appendage formed most of the right border of the cardiac shadow in the teleroentgenograms. The comparative size of the right and left sides of the heart may be judged from Figure 3 where the entire right (functionally single chambered) side is barium filled while the left side is free of barium. In the same roentgenograms can be seen the obvious dilatation of the superior vena cava, which caused widening of the shadow of the great vessels in the teleroentgenograms. The left border of the heart was formed by the right ventricle; the left ventricle is entirely hidden (behind) by the barium in the right ventricle.

Some idea of the degree of displacement of the attachment of the tricuspid valve may be obtained from the roentgenograms in Figure 3.

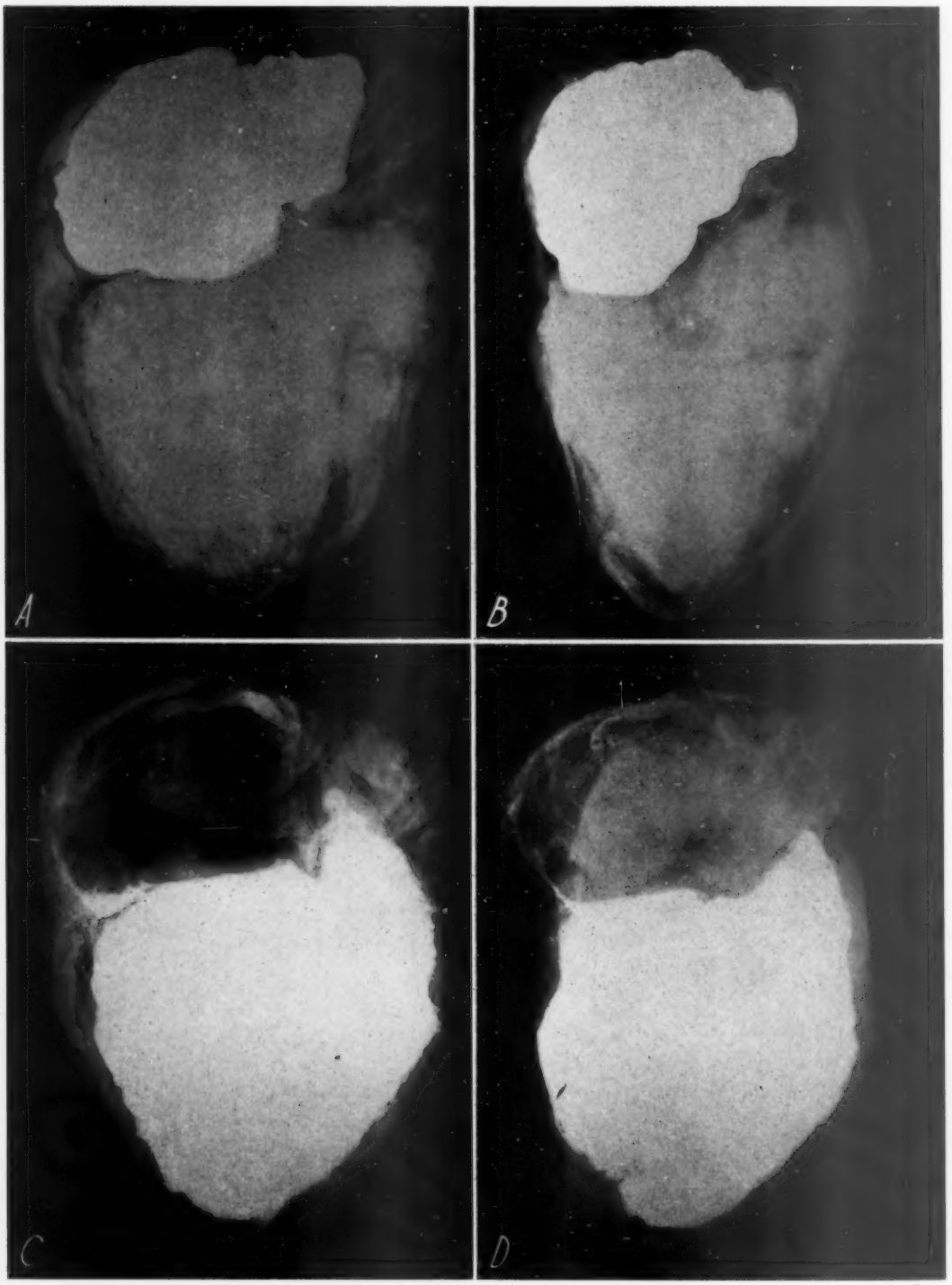

Fig. 2. *A*, posteroanterior view of heart specimen with barium in the right atrium to show that the right border of the heart in Figure 1*D* was formed by the right atrium. Compare with Figure 4*A*. *B*, right lateral view with barium in the right atrium. *C*, posteroanterior view with barium in the entire right ventricle. Compare with Figures 1*D* and 4*A*. *D*, right lateral view of the same specimen.

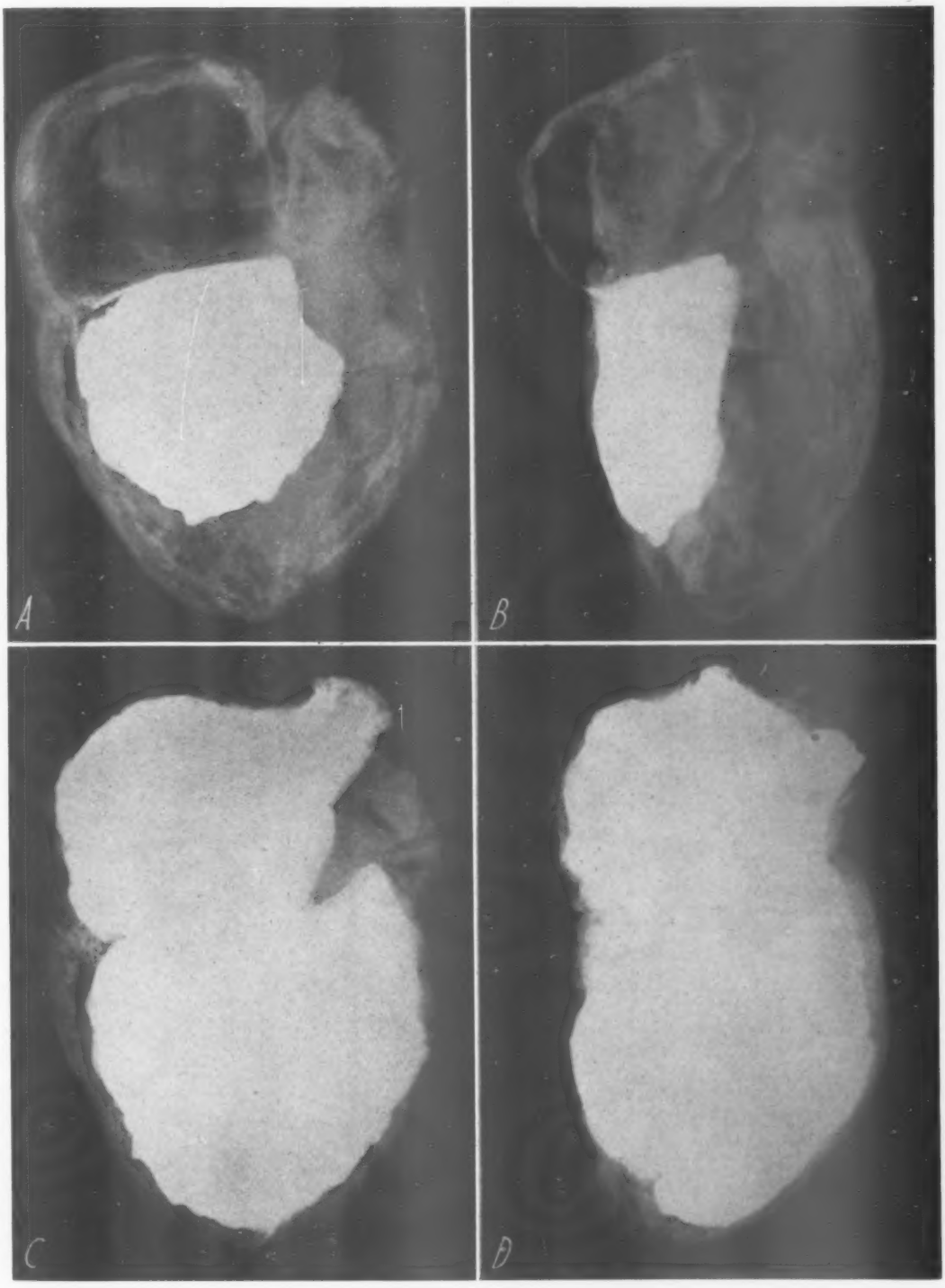

Fig. 3. *A*, posteroanterior view of the heart specimen with barium in the portion of the right ventricle (the "atrialized" portion) between the two dotted lines of Figure 4*C*. *B*, right lateral view of the same specimen. *C*, anteroposterior view with barium filling the entire right side of the heart, showing that almost none of the left side could be seen roentgenoscopically in the posteroanterior position. *D*, right lateral view of the same specimen.

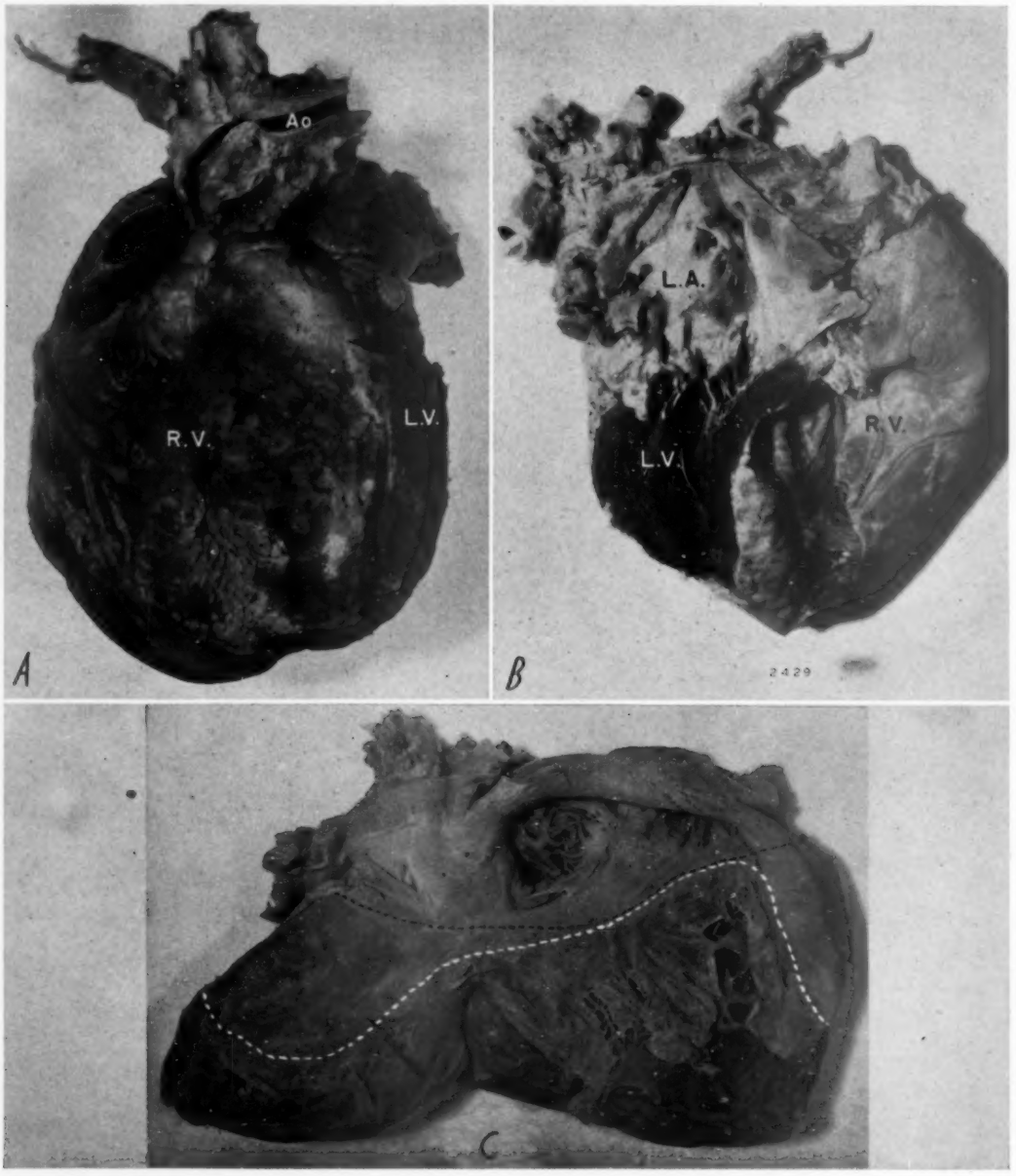

Fig. 4. *A*, anterior view of the heart specimen rotated slightly to the right to bring the left ventricle (*L.V.*) into view. The pulmonary artery, seen filled with barium in Figure 2*C*, is just below the aorta (*Ao*). The photograph shows the pericardial roughening. *B*, the relatively small left ventricle (*L.V.*) is shown in this view of the posterior aspect of the heart. The left atrium (*L.A.*) is above. *C*, the right side of the heart is opened to show the congenital defect. The black line marks the atrioventricular sulcus, the normal line of attachment for the tricuspid valve. The white line marks the actual attachment of the tricuspid valve.

The barium-filled portion here shown is that part of the right ventricle between the atrioventricular sulcus (the line of attachment of the normal tricuspid) and the actual line of attachment of the valve (Fig. 4). From the anteroposterior and lateral views it is obvious that a large portion of the right ventricle became "atrialized" by the displacement.

DISCUSSION

The gross findings are those of Ebstein's disease. "Ebstein's disease of the heart is a rare congenital malformation consisting essentially of downward displacement of the tricuspid valve in an otherwise completely developed heart. The right auricle is greatly enlarged, and the foramen ovale is usually patent. The true right auriculoventricular ostium is enlarged."[13]

The clinical findings outlined above are entirely compatible with the autopsy findings. The absence of venous pulsations in the jugular veins and the liver is not uncommon in tricuspid insufficiency when the right atrium has become greatly dilated. Cirrhotic changes in the liver, in long-standing tricuspid insufficiency, tend also to make imperceptible the pulsations of this organ. Visible pulsations of the hypertrophied and dilated right chambers were noted in the right hemithorax. Intermittent pericardial effusion was produced by the increased pressure on the coronary sinus. At the time of death there was also effusion into the pleural and pericardial cavities and acute congestion of all the viscera as a result of acute circulatory failure.

Yater and Shapiro[13] reported bundle branch block in their case. Their careful histopathologic studies failed to reveal an explanation. Their report carries no mention of pericardial effusion, but there was acute congestion of the viscera. Various degrees of heart block have been found associated with pericardial effusion, and this may be the explanation. Fibrillation, which also may be produced by effusion, was inferred from the kymogram in the present case during the patient's last hospital admission. Fibrillation may also be produced by increased pressure in the right atrium.[12] The thrill and murmurs heard are compatible with those of tricuspid insufficiency.

The immediate cause of death was acute circulatory failure. Tamponade did not initiate the difficulty. It is probable that a small amount of clear fluid was present in the pericardial sac prior to the acute episode preceding death. The addition of blood was apparently caused by the heroic treatment with intracardiac coramine, after cyanosis and coma had supervened. The evidence of chronic pericarditis may be interpreted as support for the belief that increased pressure on the coronary sinus caused intermittent pericardial effusion.

TABLE II

COMPARISON OF FINDINGS IN THREE EXAMINATIONS

Age yr.	Lungs	Pulsations	Rhythm	Median Right cm.	Median Left cm.	Vessels	QRS
18	Clear	Strong	Regular	7.5	11.0	4.6	0.15
20	Clear	No mention	Regular	8.0	11.5	4.3	0.15
27	Clear	Feeble	Fibrillation (?)	9.0	12.0	5.0	0.16

The roentgenologic evidences of tricuspid insufficiency in this case were: massive enlargement of the cardiac shadow to the right and left in the absence of pulmonary congestion and in the presence of vigorous pulsations; prominent upper mediastinal shadow with widened superior vena cava; enlargement of the right atrium and ventricle and actual difficulty in visualization of the small left ventricle.

At the time of her admission for surgical attention, the patient was a poorer risk than at any time when she had previously been seen. This statement is not intended as criticism of the treatment the patient received, because it is not evident that the operative procedure contributed in any way to her death. The comparison of findings at the time of the patient's second ad-

mission, with previous findings, provides information that should be of value in considering the prognosis of an individual with tricuspid insufficiency. Except for a slight increase in the QRS interval there was no essential change in the electrocardiogram. Physical findings had not altered. The roentgen changes were definite, however. These are set forth in Table II. There is no real mystery in the death of this patient or the patients in the other 3 cases in which sudden death has been reported. Apparently each of these individuals had exhausted the cardiac reserve so that even a minor increase in routine activities was sufficient to institute irreversible changes leading swiftly to death.

SUMMARY

A seventeenth case of congenital tricuspid insufficiency of the Ebstein type is reported. It is the fourth case with sudden death. The patient was a female, aged twenty-seven, who was studied on three occasions over a period of nine years. Postmortem roentgen studies of the heart are compared with teleroentgenograms made during life to demonstrate the changed relation of the heart chambers. Some roentgenographic observations, which may be helpful in problems of prognosis in patients known to have tricuspid insufficiency, are set forth.

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Vol. 54, No. 2

THE ROENTGENOLOGICAL MANIFESTATIONS OF AMEBIASIS OF THE LARGE INTESTINE*

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AMEBIASIS has a wide geographical distribution. In the Middle East the disease occurs endemically. In the presence of stenosis of the large intestine, roentgenologists should therefore always consider the differential diagnosis between cancer and amebiasis. At present, when members of the Army serving overseas may bring the disease home on their return, it seems necessary to draw attention to the roentgenological manifestations of amebiasis of the large intestine.

Two types of amebiasis of the colon are to be distinguished: (1) the diffuse type and (2) the localized type.

(1) *The Diffuse Type.* The lesions are scattered all over the colon, the roentgenological aspect being similar to that seen in cases of idiopathic or ulcerative colitis.

In 186 autopsies on persons dying of dysentery, Clark found 60 per cent which presented the diffuse type while in 40 per cent pathological changes of a local nature were established.

The two varieties, the diffuse and the localized, may co-exist. This means that the colon which may be affected throughout almost its whole length may, in addition, show one or several stenosed areas.

(2) *The Localized Type.* This type gives a more characteristic roentgen appearance. The individual portions of the colon are involved in the following order of frequency: cecum, ascending colon up to the hepatic flexure, sigmoid, rectum. It appears that the opaque enema is more reliable and should be preferred to the barium meal.

"Amebic granuloma" in conjunction with excessive scarring (spasms, edema and pericolic inflammatory tissue) may lead to partial obstruction of the lumen, creating the impression that one is dealing with cancer of the colon, and operations have even been performed because of this misleading appearance.

Before embarking upon a detailed analysis of the roentgen manifestations of amebiasis, it should be emphasized that close cooperation between clinic, laboratory and roentgen department is indispensable in order to establish the definite diagnosis of an amebic filling defect. The roentgenological distinction between stenosis due to amebic granuloma and that due to malignant new growth is based on the following points:

(1) In amebiasis the colic and pericolic inflammatory process usually occupies an extensive segment of the colon, while cancer is practically confined to a relatively short portion of the large intestine (Fig. 1).

FIG. 1. There is an area of constriction about 20 cm. long between sigmoid and descending colon. Haustration and mucosal relief are practically intact.

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Fig. 2. Two stenosed areas in the descending and one in the transverse colon.

(2) In amebiasis lesions are very frequently multiple, which is a very rare occurrence in cancer. Where, therefore, lesions are present in several sections of the colon this is strong evidence against the possibility of cancer (Fig. 2).

(3) In amebiasis the narrowing of the lumen is relatively incomplete in contradistinction to malignant stenosis, and it is owing to this incompleteness that obstructive ileus is rarely seen in amebiasis (Fig. 2).

(4) It is further on account of this incomplete constriction that the passage of the barium through the stenosed area usually causes no pain, in contrast to carcinomatous stenosis in connection with which the pain caused by the pressure of the enema on the rigid wall is so distinct that it is considered a characteristic symptom of malignancy.

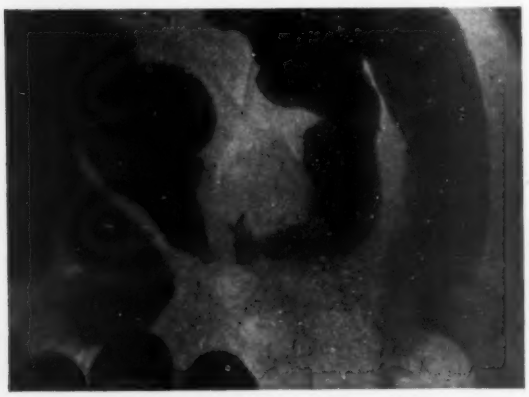

Fig. 3. Stenosed area about 6 cm. long. The transition from the involved to the normal part occurs gradually. The mucosal relief is partially intact.

Fig. 4. Stenosed segment of the descending colon. Mucosal relief as well as haustration is still distinct. The transition occurs gradually.

(5) In amebiasis the transition from the involved to the normal part of the colon occurs gradually (with no spur formation) in contrast to cancer in which an abrupt demarcation between the pathological and the normal part of the bowel is a significant feature (Fig. 3 and 4).

(6) Since in amebiasis the stenosed portion of the wall does not become completely unelastic and rigid as in cancer, the lumen appears wide on maximum filling and narrower on lesser pressure (Fig. 5, *A* and *B*).

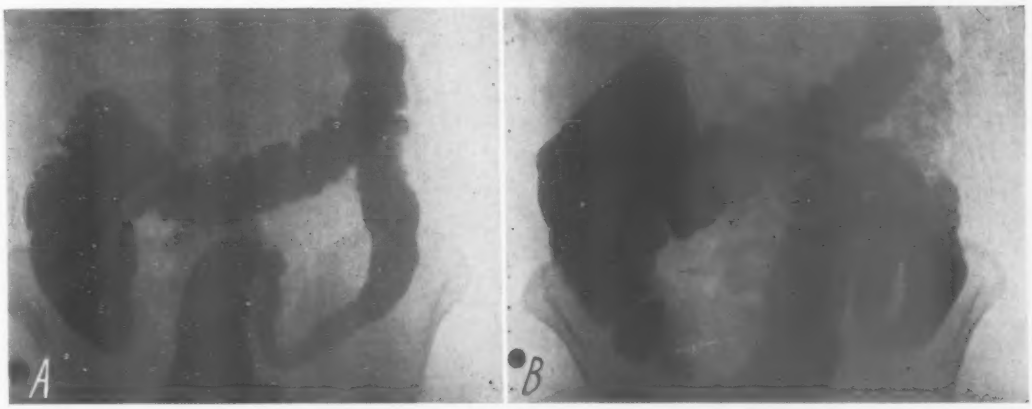

Fig. 5. A, constricted portion of colon about 12 cm. long, with gradual transition from the normal to the affected part. Haustration and mucosal relief are practically intact. (The transition is so gradual that it is impossible to draw a definite line between the normal and pathological area.) *B*, upon additional filling with barium the lumen of the constricted portion has become wider.

(7) In amebiasis the mucosal relief of the involved portions is more or less regular while in cancer it is irregular (Fig. 1, 2, 3, 4 and 5*A*).

(8) After vigorous anti-amebic treatment, follow-up examinations show a more or less complete restoration to normal. In a number of cases the site of stenosis can no longer be identified, while in others the lumen has become enlarged, the response depending on the type of case, whether stenosis was due to edema, proliferation of tissue or fibrous transformation of the granulation tissue (Fig. 6, *A* and *B*).

While in the presence of obstruction due to malignant new-growth early operation is essential, the least supicion that stenosis may be due to amebae is an absolute contraindication to operation. It should be borne in mind that laparotomy in case of latent amebic infection may endanger the patient's life and be a potential cause of death.

We saw a patient on whom gastrectomy had been performed for duodenal ulcer and in whom a latent amebic infection flared up following operation. The patient died after a short period of fever. Autopsy revealed an amebic abscess of the liver in the neighborhood of the site of operation. We also saw a case of death after colostomy performed for the relief of amebic stenosis although usually the operative mortality for this operation is negligible.

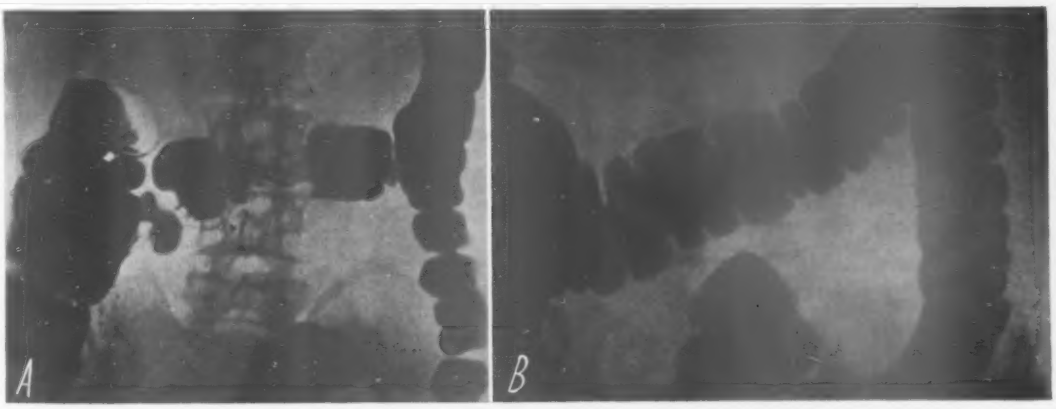

Fig. 6. *A*, narrowed area about 6 cm. long with normal mucosal relief in the middle of the transverse colon. *B*, complete disappearance of stenosis after anti-amebic treatment.

Mention should be made of the fact that amebic granulation tissue may be radiosensitive. In a case of extensive stenosis of the transverse colon laparotomy revealed an inoperable cancer. The patient was therefore given roentgen therapy following which the tumor disappeared and the normal lumen was restored (Fig. 7, *A* and *B*).

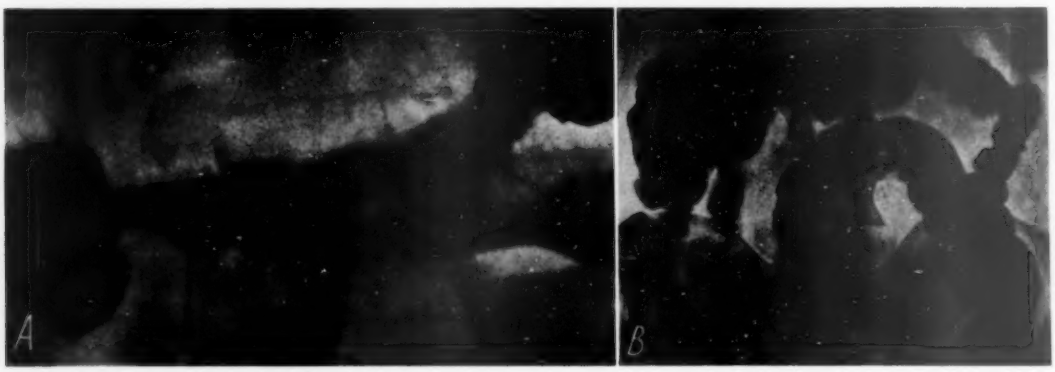

FIG. 7. *A*, very long (about 25 cm.) stenosed segment of the transverse colon. *B*, complete restoration of normal conditions after roentgen treatment.

COMMENT AND SUMMARY

Roentgen examination is very helpful in the establishment of the diagnosis of amebiasis of the colon. Roentgenologists should therefore be familiar with this condition and its roentgenological manifestations.

(1) *The Diffuse Type.* The roentgenological appearance is not characteristic and resembles that of idiopathic or ulcerative colitis.

(2) *The localized type* is characterized by

(*a*) the relative length of the stretch occupied by the filling defect of the colon;
(*b*) the often multiple occurrence of obstruction of the lumen;
(*c*) the incompleteness of the narrowing of the lumen as compared to malignant stenosis;
(*d*) the insignificance or even absence of pain upon distention by the barium enema in contrast to the acute pain of malignant stenosis;
(*e*) the frequently gradual merging of the filling defect into the normal contours of the intestine;
(*f*) the partial maintenance of elasticity of the intestinal wall in amebiasis evidenced by widening of the lumen upon introduction of barium;
(*g*) the more or less normal mucosal relief in the involved portion, and
(*h*) the more or less complete restoration to normal after vigorous antiamebic treatment.

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VOL. 54. NO. 2

THE SIGNIFICANCE OF CANNON'S POINT IN THE NORMAL AND ABNORMAL FUNCTIONS OF THE COLON*

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IF WE observe the form and filling of the normal colon twenty-four hours after a barium meal, we find an accidental form of haustration whereby the forces of kneading and propulsion have left their imprint on the drying barium. There are zones of continued filling and areas of intermissions, small balls and large sausage shaped rolled forms; and it is difficult, if not impossible, to analyze the forces which result in such an appearance.

Occasionally, however, we see a roentgenogram, taken twenty-four hours after a barium meal or even immediately after a barium enema has been expelled, where the retained barium gives a clear view of the divisions involved and of the impulses working along the colon, just as cloud formations are indefinite and variable but tell the meteorologist the forces of wind and weather.

We may note that the first part of the transverse and ascending colon up to a certain point is contracted, while the second part and the descending colon are of normal diameter (Fig. 2). In another group of cases the reverse process is evident (Fig. 1): the ascending colon and the first part of the transverse colon are wide, the second part of the transverse colon and the descending colon are contracted. Not once or twice did we note such findings, but very frequently, after we were aware of the phenomenon. At times, however, we found instead of such a division only a contraction ring at a certain point (Fig. 3).

This point where such change of diameter and function occurs can be easily established and we found it quite frequently at the right side of the spine between the first and second third of the transverse colon; never much farther distal than the middle third, never as far proximal as the right flexure. Such repeated observation convinces me that the point is of great functional significance.

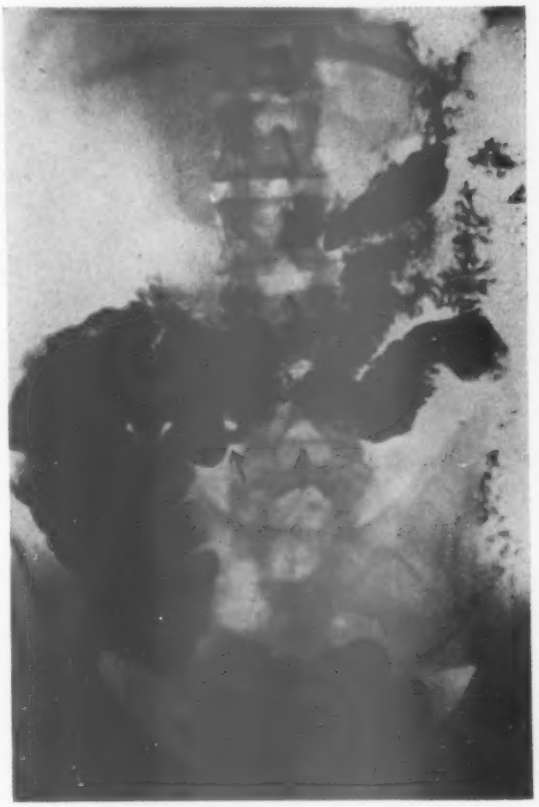

FIG. 1. Demarcation of Cannon's point (arrow). Ascending and transverse colon wide up to Cannon's point, transverse and descending colon contracted beginning at this point.

In preparation for animal experiments, I found the surprising fact that such animals as rabbits and cats not only occasionally show such a division of the colon, but that the division is regularly established is well

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Fig. 2. The reverse process: contraction of the first neurological unit, normal wide second neurological unit. Cannon's point clearly marked.

known to experimental physiologists, and was demonstrated by Garry in a form which shows close analogy to the colon in man (Fig. 4).

The earliest observations concerning this phenomenon were made by Cannon who, experimenting on animals, found and described in 1902 a ring of contraction in the large bowel of the cat, which divides the colon into two partitions. His findings were confirmed by Boehm about thirty years ago who, first in rabbits and later in man, found the same contraction in the transverse colon and observed different functions on both sides of it: tonic contraction and antiperistalsis in the proximal part, deep segmentation and ball formation in the distal part of the colon. Case, in his study of colon motility, peristalsis, and antiperistalsis, observed the phenomenon of the contraction ring in man usually to the right of the midline in the transverse colon, confirming the earlier work of Cannon and adding many new observations which he presented at the Seventeenth International Congress of Medicine in London in 1913. He showed that the prevailing movement in the proximal colon is antiperistalsis, the movement of waves backward towards the cecum, while the distal colon has as its characteristic motility an onward movement.

These important findings seemed to be neglected during the following years, probably because it was felt they were of no clinical significance. Only once in discussing several other "sphincters" along the colon does Balli mention that area as another sphincter location. It is my opinion that most of these sphincters, with the possible exception of the ileocolic, are reflexes and do not have the anatomical structure of a sphincter.

I suggested that this significant point be called Cannon-Boehm's point in honor of

Fig. 3. The ring-like form of spastic contraction at Cannon's point. For explanation see text.

the early observers and it is referred to as such in recent literature. In one fact of great significance I am departing, however, completely from the explanation given by Cannon, Boehm, and Balli. Cannon observed here a contraction ring; Boehm functional divisions between the first and second part of the colon of the cat; Buzzi and Balli described it vaguely as a sphincter. No hypertrophy of muscle fibers or no accumulation of ganglion cells suggestive of a sphincter has ever been found in that area. Our own examinations over a long period of time have not shown anything which could remotely be interpreted as a sphincter and no explanation has ever been offered for the occurrence of such a contraction ring in the midst of the easily passable transverse colon.

The explanation we offer, based on roentgen observations, is that it is the pivoting point of a change in nerve innervation between the vagus and the pelvicus, and on the sympathetic side between the splanchnicus superior and inferior. The point where such change occurs has always been questionable. The majority of writers hold that

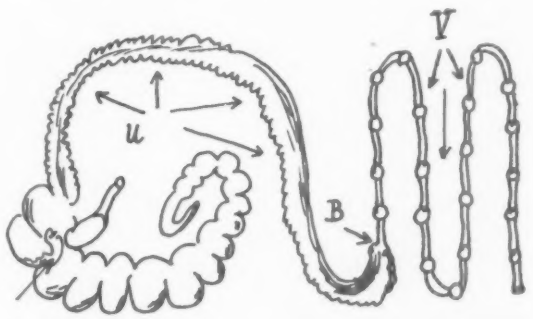


Fig. 4. The division of the colon in cats and rabbits into two units with Cannon's point at *B* (from Garry). *S*, cecum; *U*, proximal colon; *V*, distal colon.

fibers of the vagus nerve down from the celiac plexus follow the vessels and supply the small intestine, the ascending colon, and a questionable part of the transverse colon (Fig. 5). Fibers going from the right, dorsal vagus to the ascending and transverse colon are described by Delmax and Laux, and by Jayle and Cabanac. But just how far down such innervation goes could not be made clear by the anatomical or any other method. That the lower part of the colon and the rectum receives its innervation from the plexus sacralis and the pelvic

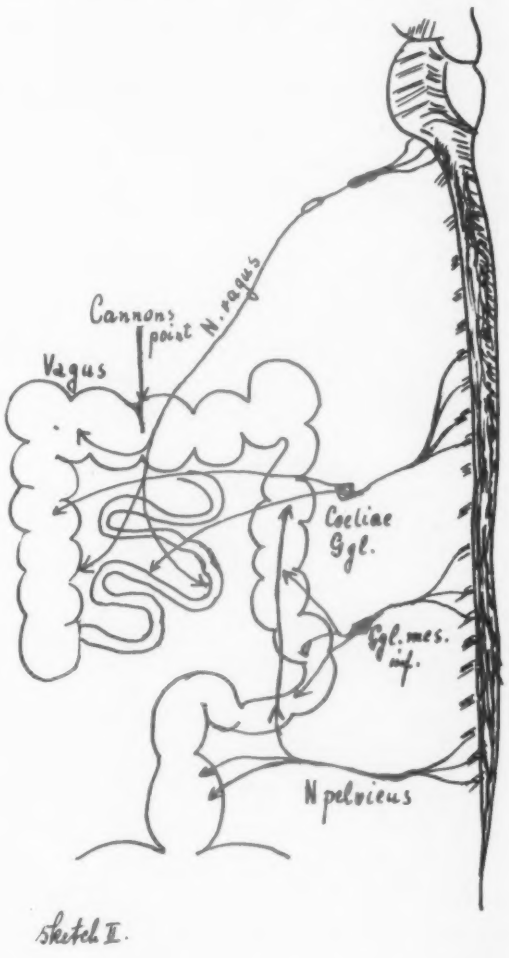
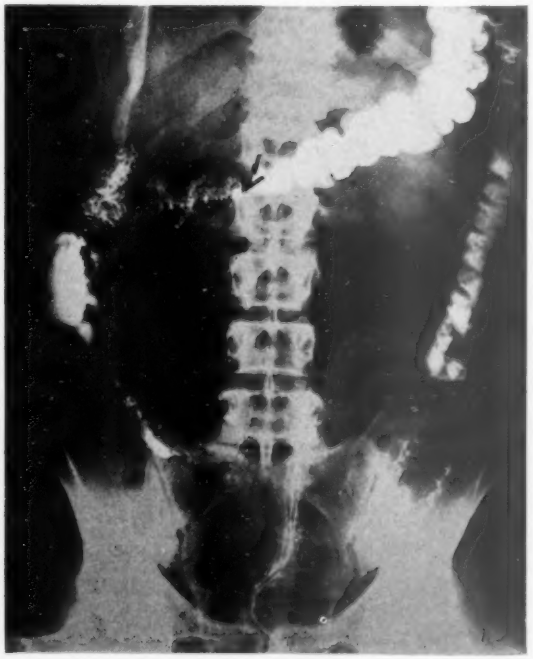


Fig. 5. Schematic drawing of the coordinated or at times antagonistic colon innervation.

nerve is more uniformly acknowledged. The only question and one which has been much debated was the exact location of the innervation. Is it at the rectum, as some authors have thought, or at the ileojejunal flexure, or somewhere in between? Our roentgenological observations make it appear *very probable that Cannon's point is where such a shift takes place.*

Fig. 6. Clear example of demarcation of the two neurological units: the first one (vagus) contracted, the second one of normal width.

Fig. 7. Observation of the reverse process: first neurological entity wide, second contracted, the pivoting point being Cannon's point.



Figs. 8 and 9. Further examples of the antagonistic innervations, transition at Cannon's point.

In order to appear visible in roentgenograms, an antagonism between both spheres of influence must occur; either the distal part has to be wide and relaxed and the proximal part has to be contracted, or the reverse must be the case. The phenomenon of the contraction ring, misinterpreted as sphincter, permits the explanation of a critical reaction at the point of overlapping nerve impulses (Fig. 6–9).

Our roentgenological observation finds its support in embryology where the ascending colon with the large cecum and part of the transverse colon participate in the formation of the umbilical loop and have a common blood supply from the superior mesenteric artery, while the descending colon, a segment of the transverse colon, the sigmoid and the rectum receive their blood supply from the inferior mesenteric artery. It was Testus-Latarget who stated that embryologically the nerve innervation follows the blood supply.

So it is of no more than academic importance, especially for the roentgenologist, how much of the large bowel we call ascending, transverse and descending colon; it is more important to know that there are two distinct nerve and blood supply units, the point of transition of the extrinsic nerve impulses being Cannon's point, as we believe. Not only do peristaltic waves flatten out or reverse themselves at this point, but it is the proximal part of the colon which is the relatively quiet part of the colon, while beyond Cannon's point the great driving movements have their origin.

The knowledge of such a functional antagonism is of great clinical significance: (1) In the explanation of that type of constipation which has been called the ascending colon type. The characteristic of this type of constipation on roentgenograms is the long delay of the barium propulsion beyond the ascending colon. But such a careful observer as Stierlin mentions and stresses that the head of the barium column is frequently arrested somewhat distal to the right flexure.

In order to have normal movement and propulsion, both neurological units have to be correctly charged (to use a term of electricity) with the correct nerve impulse. If the first unit is positive—that is, in contraction—and the second unit wide and receptive, there is no delay at Cannon's point and therefore normal propulsion; if, however, the second unit is contracted and the first unit does not have the necessary strong impulse, we might find the frequently observed and unexplained antiperistalsis and as it subsides we find the resulting constipation of the ascending colon.

The observations of Mony and Vernet that kidney stones are frequently accompanied by constipation and very painful spasm and contraction of the descending and transverse colon are well explained as intestinal reflexes due to the close association between the pelvic nerve and the bladder and kidney innervation causing such a blocking impulse on the second neurological unit.

(2) It is significant that certain affections of the colon, even ulcerative colitis, are frequently confined to the second neurological and blood supply unit. We frequently state that the descending colon is involved, and the ascending colon is normal; but again, quoting an autopsy report from Stierlin's classical work, we find him describing a severe ulcerative colitis: "Ascending colon and proximal half of the transverse colon are normal, ulcers with undermined edges begin at the middle part of the transverse colon." We find many more such examples in the older literature, not so much, however, in recent literature, as these observations of an earlier era have been forgotten. In contrast, tuberculosis involves to a greater extent the first unit and causes spasticity and filling defects (Stierlin's sign), in the entire vagus unit frequently beyond the area of involvement.

(3) It is important in the operation for megacolon. The extent and the localization of the involvement are especially important in the choice of the operation. We know

that the complete elimination of the parasympathetic nerves results experimentally in megacolon. Wade and Royle first used sympathectomy in a ten year old child as treatment for megacolon, while Rankin and Learmonth introduced the operation of the sympathetic fibers collected in the plexus mesenteric inferior and plexus hypogastric, thus doing a partial sympathectomy instead of a radical, if only the upper abnormal colon was involved up to the right flexure; and, as we have demonstrated, somewhat beyond it the sympathetic innervation comes down from the prevertebral ganglia of the sixth lower thoracic segments collected in the celiac ganglion, while the transverse and descending colon, and rectum receive their sympathetic innervation from the lumbar segments collected in the inferior mesenteric ganglion.

Thus we distinguish according to Pässler three groups of megacolon: (1) without involvement of the descending colon, sigmoid, and rectum, *with innervation from the mesenteric plexus, superior;* (2) the descending colon and the sigmoid involved, but not the rectum, *with innervation from the mesenteric plexus, inferior* (with anastomosis from the superior plexus); (3) the megarectum and bladder *with innervation from the hypogastric plexus.*

For the first group Pässler advocates Adson's operation of bilateral resection of the lumbar ganglia, but operation of the mesenteric plexus, inferior and hypogastric plexus is unnecessary. The second group should have the Rankin-Learmonth operation. The third group, involving rectum and bladder, should have resection of the hypogastric plexus.

Thus our roentgenological observation, while confirming the frequent occurrence of a contraction ring at Cannon's point as seen by earlier observers (Boehm, Case), shows just as frequently a different degree of contraction of the colon on both sides of that point and indicates, in our opinion, that this point is not the location of a sphincter or an incidental activated spasm, but an important point of transition of the entire extrinsic innervation.

The general conception of a neurological division of the colon into two or three units visible in roentgenograms, which might either harmonize or antagonize one another, appears important to the surgeon as well as to the roentgenologist and internist.

Beyond such immediate usefulness, it is one more observation of a living organ in its function rather than its form. The present-day and future task of the roentgenologist is the study of function rather than of form. Instead of the still life picture of the heart, stomach, and colon we will have in the future the cineroentgenographic and telescopic picture of the complete function of these organs. Disturbed function precedes deformity. Function, on the other hand, has many possibilities of fulfillment under various forms. The colon is especially rich in variations, which to a large extent are efficient in function. If the anatomist Bosch is reported to have said he never saw a normal colon, he was not brought up in the school of the anatomia animata of Lamark and Haller. It is function which creates and changes forms. If we ever hope to make an early diagnosis and institute efficient cure, it will be through finer methods of observing disturbed function roentgenologically and otherwise.

SUMMARY

1. A point in the proximal mid-third of the transverse colon, corresponding to the contraction ring in the large bowel of animals, first described by Cannon, is also found in man. It is of clinical and roentgenological significance and should be called Cannon's point.

2. Our roentgenological observations indicate that it is the pivoting point of the vagus-pelvicus and of the sympathetic innervation, thus dividing the colon into two distinct neurological units as far as the extrinsic innervation is concerned. The innervation follows herein the blood supply.

3. To be visible in roentgenograms, an

antagonism between both neurological units is necessary; if the nerve impulses in both divisions are the same, no demarcation can be expected; if they are antagonistic, however, the division is clearly visible. Instead of the antagonism we sometimes see in the case of overlapping impulses a contraction ring caused by intrinsic nerve impulses.

4. Both units may be harmonious or antagonistic. Spastic contraction of the second unit is a frequent cause of constipation in the ascending colon and is best treated by antispasmodics.

5. The proper knowledge of the neurological units is important in differentiation and choice of the operative method of the different types of megacolon.

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SKELETAL METASTASES IN CANCER OF THE BREAST

STUDY OF THE CHARACTER, INCIDENCE AND RESPONSE TO ROENTGEN THERAPY*

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"AS a palliative method, radiation causes complete regression of many local recurrences. Some of the most striking results are seen in the control of bone metastases, in which pain is relieved, the bone structure restored, and life prolonged" (Ewing).[5]

Too many cases of cancer of the breast with skeletal metastases are considered totally hopeless and doomed to death at an early date no matter what one might attempt in the way of treatment. Such an attitude seems to be unjustifiable.

A critical study of a series of consecutive cases of cancer of the breast showing unquestionable evidence of osseous neoplastic involvement, with particular reference to the value of palliative therapy, is reported here in support of this argument.

Since 1938, 180 cases of cancer of the breast, in various stages, have been treated in the Department of Radiology at the Royal Victoria Hospital. Among these cases, 37 showed definite evidence of skeletal metastases, roentgenographically, with a total mortality of 24 up to the present time. As the majority of the whole series are still living, we do not believe sufficient time has elapsed to use those figures to establish a morbidity rate with skeletal metastases. Ewing[5] has reported that Gross found the incidence to be 20.5 per cent in a series of 423 autopsies, while Kaufman found 53.0 per cent in 63 autopsies. I am inclined to feel that the first figure is too low and the latter too high; the mean would probably be close to reality. Repeated routine roentgenographic examinations in a large series of cases should prove to be a definite adjunct to postmortem examinations in determining such morbidity rate.

As one surveys the literature, very few studies of large series of cases of skeletal metastases from cancer of the breast are to be found in which the effect of roentgen therapy has been discussed. In 1931, Lenz and Freid[9] published their findings in 81 cases. Geschickter and Copeland[7] reported the results they obtained in 34 cases. The best paper on the subject, in my opinion, is that of Wulff,[11] of Lund, Sweden, dealing with 44 cases treated between 1929 and 1937. The only criticism that one could make with regard to Wulff's paper is that he included the cases of patients still living, with the result that some of his figures were not final. To avoid that pitfall, I have confined the present study to an analysis of but 24 of the 37 cases which have been treated in the Department of Radiology of the Royal Victoria Hospital since 1938, and have not included any who still survive.

CLASSIFICATION OF CASES

Bearing in mind that a very exact and accurate classification of cases is essential in the study of carcinoma of the breast, considerable care and attention has been devoted to that matter. The old classification of Steinthal has been discarded in favor of that of Portmann[10] which is more accurate and logical, as it is based not only on clinical, but also on pathological findings. This permits a more precise appreciation as to the extent of the disease. For example, the axillary glands are recorded as involved only if so demonstrated by pathological sections. Portmann's classification also allows for consideration of distant metastases, without regard to the degree of involvement of the breast alone. The details of that classification are as follows:

* From the Department of Radiology of Royal Victoria Hospital and McGill University.

Group I

(*a*) *Tumor* definitely localized to the breast and movable;
(*b*) *Skin* not involved;
(*c*) *Metastases* not present in axillary lymph glands.

Group II

(*a*) *Tumor* localized to the breast and movable;
(*b*) *Skin* not affected (or only very slightly edematous or ulcerated);
(*c*) *Metastases* present in axillary lymph glands but few involved.

Group III

(*a*) *Tumor* diffusely involving the breast;
(*b*) *Skin* involved (edematous, ulcerated), multiple nodules);
(*c*) *Metastases* to numerous axillary lymph glands or to other tissue (supraclavicular nodes, lungs, bones, etc.).

Cases have been classified as indicated in Table I according to the clinical, pathological and roentgenographic findings. As one would logically expect, it is in the Group II and III cases that skeletal metastases are most frequent. One case could not be classified due to the lack of complete data.

TABLE I

CLINICAL AND PATHOLOGICAL CLASSIFICATION (PORTMANN)

Group	No. of Cases	Per Cent
I	3	12.5
II	9	37.5
III	11	45.8
Unclassifiable	1	4.2
Total	24	100.0

LOCATION OF THE PRIMARY TUMOR

It is the general experience that the left breast is more often involved than the right. Our series is in accord with this, since in 13 of the 24 patients the primary lesion was in the left breast.

Not a single case was bilateral from the onset, although extension to the opposite breast occurred in 5 cases. Two of these presented the so-called "inflammatory" type of carcinoma. Another had a right radical mastectomy sixteen years before the appearance of cancer in the left breast without any evidence of local recurrence or distant metastasis in the interval.

For the purpose of the present discussion, it is considered that any cancer developing in the opposite breast ten years or more after the first is an entirely new growth having no direct relationship whatsoever with the previous contralateral carcinoma. For the above reason, in our analysis the skeletal metastases are assumed to be related only to the carcinoma of the left breast in the case just mentioned.

So far as I can determine, there is no appreciable connection between the location of the primary tumor in the breast itself and the incidence of skeletal metastases. In other words, the frequency of dissemination of neoplastic cells to bone bears no significant relationship to the quadrant of the breast in which the primary tumor may have originated.

PATHOLOGY

Biopsy of the primary tumor was taken in 5 cases only. However, unquestionable proof of cancer was obtained in all the other cases from the microscopic examination of surgical specimens. Our pathological material does not permit us to infer that skeletal metastases are more frequent with one histopathological type of tumor than with another. The rate of growth, degree of anaplasia, and extent of the pathological process in the breast and its draining lymphatics seem to be more indicative histopathological findings as to the probability of subsequent or ultimate skeletal involvement than the type of tumor. Lenz and Freid[9] attach primary importance to the pathological grading as an indication of the degree of malignancy by a correlation of grading on the one hand, and the prognosis or survival, on the other.

The histopathologic proof of osseous metastases has become available in only 3 cases by means of postmortem examination. For all our patients roentgenographic evidence as well as the clinical course was

required to establish a diagnosis of skeletal metastases.

AGE FACTOR

The age factor does not seem to play any important rôle in regard to the incidence of bone lesions. The age varies from twenty-four to seventy-seven years at the apparent onset of the tumor. The average age for all cases was 44.4 years.

TABLE II

GROUPING OF PATIENTS ACCORDING TO AGE AT ONSET OF TUMOR

Decade	No. of Cases	Per Cent
20–30	2	8.5
30–40	6	25.0
40–50	10	41.3
50–80	5	21.0
Age unknown	1	4.2
Total	24	100.0

Grouping patients by decades of age (Table II) does not indicate in any way that metastases to bone occur more often in younger than in older patients. The rate of frequency merely follows the usual curve of incidence of cancer of the breast. Just as cancer of the breast is more common in the age group forty to fifty than in any other, it is during that decade that we find the highest incidence of skeletal metastases.

INTERVAL BETWEEN ONSET OF PRIMARY GROWTH AND ROENTGENOGRAPHIC EVIDENCE OF SKELETAL METASTASES

The exact date of onset of any cancer is almost impossible to determine. Nevertheless, if we take as a starting point the time at which a patient has first noticed the presence in the breast of a growing tumor on the one hand, and when roentgenographic examination has first demonstrated evidence of skeletal metastases on the other, we obtain some interesting data.

The interval between the apparent onset of the breast tumor and that of neoplastic invasion of bone varied from three months to seventeen years. The mean interval for all cases without discrimination is 45.3 months. However, if we exclude 2 cases for which the interval has been exceptionally long, that is nine and seventeen years respectively, we find a mean interval of thirty-four months. The latter figure, I believe, is more factual than the former, and should be retained in preference. Table III also indicates that skeletal metastases would appear to occur earlier in the twenty to thirty year age group than in any other. This was to be expected as we know that cancer in that decade of life is usually more malignant and evolves more rapidly.

TABLE III

AVERAGE INTERVAL IN MONTHS BETWEEN KNOWN ONSET OF PRIMARY GROWTH AND ROENTGENOGRAPHIC EVIDENCE OF SKELETAL METASTASES

Interval varies from 3 months to 17 years

Decade	Months
20–30	22.0
30–40	42.0
40–50	46.3
50–80	46.2
Gross mean interval: 45.3 months	
Net mean interval: 34.0 months	

Analysis of the above data permits us to substantiate the exactness of the following rule expressed by Wulff:[11] the longer the interval between the apparent onset of the primary growth and that of the skeletal metastases, the longer the survival.

INCIDENCE AND ORDER OF INVOLVEMENT OF BONES

The predominance of involvement of certain bones in cancer of the breast is well known. Handley[8] long ago demonstrated that it is due to anatomical conditions, mainly in relationship to the regional mode of extension of that particular type of neoplasm.

Table IV indicates the rate of incidence of metastases to certain parts of the skeleton in our series of cases. There seems to be a close parallel between the rate of incidence and the order in time in which the same bones are involved. Generally speaking, our figures are relatively in accordance with those published by others. From this analysis I wish to emphasize the neces-

sity of a systematic and careful investigation for bone involvement in cancer of the breast especially in pelvis, lumbosacral vertebrae, ribs, dorsal vertebrae and femora. Skeletal metastases below the elbow and knee have not been found in the present series. Although a few cases have been reported in the literature by Lenz and Freid,[9] Copeland,[4] Carnett and Howell,[2] as well as Clarkson and Barker,[3] they are exceptional.

TABLE IV

INCIDENCE AND ORDER OF INVOLVEMENT OF VARIOUS BONES

	Per Cent		Per Cent
Pelvic bones	75.0	Cervical vertebrae	33.0
Lumbosacral vertebrae	71.0	Skull	25.0
Ribs	71.0	Scapula	25.0
Dorsal vertebrae	62.5	Humerus	12.5
Femur	54.0	Clavicle	8.3
		Sternum	8.3

ROENTGENOGRAPHIC ASPECT OF OSSEOUS LESIONS

Bone metastases from cancer of the breast when first discovered are sometimes single, but more often multiple lesions. Eventually they nearly always become multiple.

There are three general types:

(1) The *osteolytic* type seems to be by far the most common when first discovered, since we observed that character of bone change in 75 per cent of the cases. The lesion is characterized by areas of bone erosion with complete destruction of trabeculae developing in either the spongiosa or the cortex, depending upon the bone involved. The destructive process may be more or less diffuse in appearance, or be sharply circumscribed as though the bone had been punched out (Fig. 1*A*, 2*A*, 3*A*, 4*A* and 8*A*).

(2) The *osteoblastic* type presents an entirely different picture. Roentgenograms show areas of markedly increased density in which the bone trabeculae are no longer identifiable and seem to have been replaced with abundant calcium salts and sclerotic tissue. The true osteoblastic type has been found as the first manifestation of skeletal metastasis in only 8.3 per cent of our patients (Fig. 5, 7*A*, 8*A* and 9).

(3) The *osteolytic-osteoblastic* type of lesion is an intricate blending of the other two. It shows on roentgenograms as islands of bone destruction surrounded with rings or strands of very dense and coarse bone. We have observed that appearance on the initial roentgenographic examination showing distant neoplastic involvement in 16.7 per cent of the cases (Fig. 6).

We may find any of the three types of lesions in the same patient on subsequent examination throughout the course of the disease.

TABLE V

ROENTGENOGRAPHIC ASPECT OF OSSEOUS METASTATIC LESIONS

Type of Lesion	No. of Cases	Per Cent
Osteolytic	18	75.0
Osteoblastic	2	8.3
Osteolytic-osteoblastic	4	16.7
Total	24	100.0

Wulff,[11] basing his opinion on the work done by Hellner and Axhausen (who demonstrated that microscopically every bone tumor either primary or secondary is at the beginning osteolytic in type), has written that if all cases of skeletal metastases were examined roentgenologically early enough, and if the neoplastic foci were sufficiently large the osteolytic type of lesion would always be found. The other types would only show later in the course of the disease. Wulff[11] also postulates that the osteoblastic predominance in any lesion is an indication that the bone lesion is growing slowly. This agrees with our observations and experience.

DIAGNOSIS

The majority of the cases have clinical symptoms which give rise to suspicion that metastases exist in bone. The usual complaint was "rheumatic" or "neuralgic" pains, often of the referred type. In some cases there was no complaint of pain, but a thorough physical examination for follow-up purposes had revealed the presence of

local tenderness. Subsequent roentgenographic examination demonstrated definite evidence of secondary neoplastic lesions. As with other authors, we often observed that sometimes pain precedes by several months the roentgenographic confirmation of skeletal metastases. As in Lenz and Freid's series,[9] we also noticed that whenever metastases develop in regions of the skeleton where the natural body weight and muscular traction are more pronounced the pain is sharper and comes on earlier.

In a few exceptional cases which manifested no clinical symptoms or signs whatsoever of bone metastasis, the diagnosis was established by means of the routine roentgen examination made to determine whether or not the skeleton was involved. In any patient with local recurrences or regional metastases, the possibility of bone involvement by neoplastic cells in the process of dissemination must be considered and searched for.

Occasionally the incidental finding of an unsuspected skeletal metastatic lesion will lead to the discovery of cancer of the breast itself. One of our patients had been complaining of sciatic pain, and for eight months before coming to the Royal Victoria Hospital had received treatment without any improvement. Roentgenograms made on admission demonstrated in the pelvis and right femur bone lesions resembling metastases. Search for the primary revealed a small cancer in the right breast.

PRINCIPAL ASSOCIATED METASTASES

In 17 of the 24 cases, i.e. 62.5 per cent, skeletal lesions were the first metastases to be found and the only ones demonstrable for some time. Two patients only, that is 8.3 per cent, never at any time showed any appreciable evidence of metastases elsewhere save in the skeleton. From a careful study of the history of each individual case, I have gained the definite impression that so long as certain other metastases are not associated with those to bone, the immediate prognosis is not as bad as one would be inclined to feel. It seems that the association of pleuropulmonary or hepatic metastases causes the prognosis to deteriorate progressively. Cerebral metastases, except in generalized and rapidly evolving carcinomatosis, do not necessarily mean that the end is approaching. One such patient survived in relatively good condition for almost a year in spite of cerebral and vertebral metastases with the help of palliative roentgen therapy. The final and rapid retrogressive course occupied only a month.

It is not possible to establish any pattern or order in time of incidence of the principal associated metastases in contradistinction to the pattern of skeletal involvement.

The rate of incidence has been tabulated in Table VI.

Table VI

PRINCIPAL ASSOCIATED METASTASES

	Per Cent
Cutaneous	60.8
Pleuropulmonary	54.2
Mediastinal and parasternal nodes	41.6
Supraclavicular nodes	37.5
Cerebral	20.8
Hepatic	16.6

TREATMENT OF THE PRIMARY TUMOR

One may well wonder if there can be any relationship between the incidence of skeletal metastases and any selected method of treatment of the primary in any given group. In our series, such proved to be impossible to establish in view of the fact that too many varieties and combinations of treatment of the primary tumor had been used.

Table VII

TREATMENT APPLIED TO THE PRIMARY TUMOR

Surgery	No. of Cases	Roentgen Therapy	No. of Cases
Inoperable	3	Only	2
Radical mastectomy	17	Preoperatively	1
Simple mastectomy	3	Postoperatively	10
Excision of tumor	1	No irradiation	11
	24		24

However, 3 patients in Group III considered absolutely inoperable and hopeless by the surgeons, and who were treated with irradiation only, not only survived twice as long as the others in the same

Fig. 1. Case 1. *A*, osteolytic lesion in the right ilium as indicated by black arrows. *B*, osteoblastic repair seven months after roentgen therapy (6,800 r).

group but had both subjective and objective improvement of skeletal metastases. This, in my opinion, is an argument against the use of surgery in patients of that group, and suggests the value of suitable roentgen therapy.

TREATMENT OF SKELETAL METASTASES AND RESULTS

Roentgen therapy was administered as a palliative measure for the skeletal metastases to 23 of the 24 patients. The following technical factors were used: 200 kv., 50 cm. focal skin distance, and 1.0 or 2.0 mm. Cu filter. Depending on which filter we used, the half-value layer was 1.35 or 2.00 mm. Cu, and the effective wave length 0.13 or 0.11 A° respectively. The size and number of fields varied with the region to be treated. Daily doses of 150 r per field were given, two fields usually being treated at each session, up to a total dose of 2,000 to 4,000 r, measured in air.

The results of treatment can be classified in three categories (Wulff):[11] First, the negative results in which neither relief of pain nor improvement of the roentgenologic signs was accomplished during the weeks and months following administration of the treatment (Case v). Survival periods for this group of cases varied between three and twenty-four months, the average being 9.3 months. Eight of our patients, i.e. 34.8 per cent, fall in this category. Incidentally, we noted that the same patients did not respond more favorably to any other form of therapy.

The second category is that in which a definite subjective improvement was observed. Pain was obviously relieved, as a rule, after the first four to six doses, and subsequently disappeared completely for weeks and months. In many of these cases further roentgen irradiation was given successfully two or three times for recurrent symptoms. Nevertheless, no appreciable

change in the initial roentgenologic aspect of the bone lesions could be demonstrated. In spite of the relief of pain, the progression of the disease would not seem to have been materially affected or checked, although the average survival of 13.6 months for this group was longer than the former. Individual survival periods varied between six and twenty-five months. Nine of our patients, i.e. 39.1 per cent, showed subjective improvement only. If, on the other hand, we include patients of the following category who also experienced subjective improvement, we arrive at a total of 15, or 65.2 per cent, of all the cases.

The third, or last, category, and perhaps the most interesting, includes the cases in which not only pain was relieved but also unquestionable roentgenographic evidence of objective improvement was observed. Further extension of the initial destructive bone lesions stopped and the area gradually became denser (Fig. 1, *A* and *B*), with, in some cases, eventual excessive recalcification (Fig. 2, *A*, *B* and *C*). Often, as also observed and described by Adair[1] and by Wulff,[11] the punched out areas filled progressively from the periphery toward the center, the latter remaining radiolucent for a longer time before finally filling with calcium salts (Fig. 4, *A* and *B*). In other words, depending on its initial type, the skeletal lesion passes successively from the osteolytic to the osteolytic-osteoblastic phase and then may take on the osteoblastic appearance. In a few cases, as emphasized by Wulff, the bone reaction goes one step farther, and apparent healing occurs (Fig. 3, *A*, *B* and *C*). The lesion which either initially appeared or, following roentgen treatment, gradually became osteoblastic in type, may regress and decrease in density with eventually partial to complete reorganization of bone trabeculae (Fig. 7, *A* and *B*, and 9, *A* and *B*). Roentgenologically, we have observed that it usually takes at least two months, from the beginning of administration of roentgen therapy, before any definite evidence of bone repair appears. Optimum healing may require an interval of six to twelve months, as in Case III (Fig. 3, *A*, *B* and *C*). Six cases, or 26.1 per cent, were to be classified in this third category. The average survival is

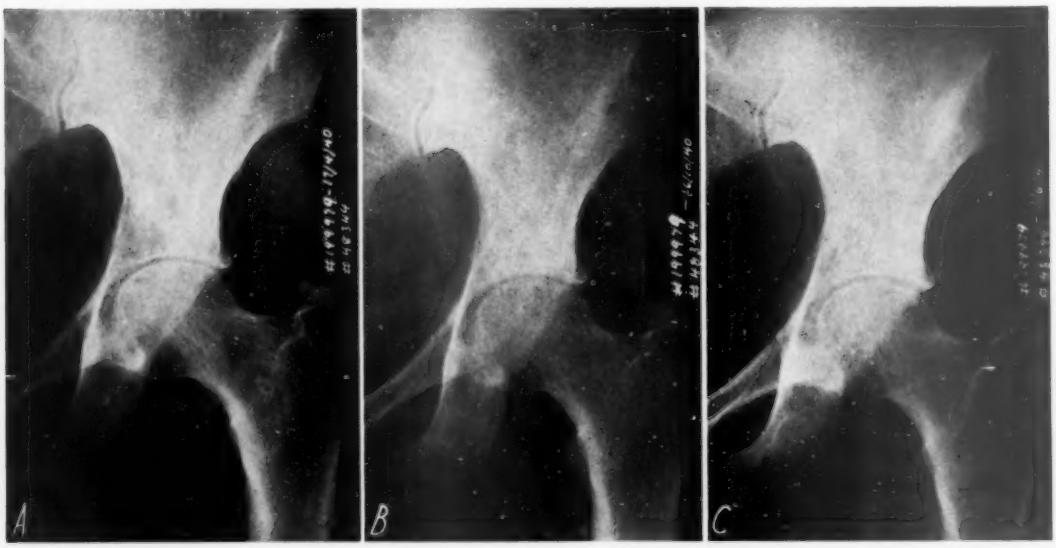

Fig. 2. Case II. *A*, April, 1940. Osteolytic process in left acetabulum treated with roentgen irradiation (5,450 r). *B*, October, 1940. Partial repair, the lesion now having the osteolytic-osteoblastic appearance. *C*, June, 1941. Further improvement of bone lesion which has become osteoblastic. Patient remained free from pain after treatment.

FIG. 3. Case III. *A*, May, 1939. Large destructive metastasis in shaft of right femur. Roentgen therapy was used with a total dose of 1,500 r only. *B*, July, 1940. Complete and exaggerated repair reaction at the osteoblastic stage. *C*, January, 1940. *Restitutio ad integrum*, which has persisted.

17.5 months while the individual cases vary from eight to twenty-nine months (Cases I, II, III, IV, VI and VII).

At this point we must state that roentgen irradiation may not deserve all the credit for objective improvement observed following this treatment. We have found many instances in which lesions spontaneously passed from the osteolytic to the osteoblastic phase (Fig. 5). All one can say in regard to the rôle of irradiation is that it probably reduces or prevents further activity of the neoplasm, with the resultant normal reparative reaction in the involved bone. Although spontaneous *restitutio ad integrum* in bone metastases of such cases may occur, we believe that beyond the osteoblastic phase any appreciable degree of bone regeneration may be attributed to the irradiation administered.

As an additional therapeutic measure, in 3 cases the pituitary and ovaries were given

FIG. 4. Case IV. *A*, multiple punched out areas of bone due to metastases in iliac bones and left sacroiliac region. *B*, marked osteoblastic reaction indicating healing seven months after roentgen therapy (4,000 r).

Fig. 5. Case IV. Osteoblastic reaction which occurred spontaneously, i.e. without roentgen irradiation, and followed osteolytic changes in the fourth dorsal vertebra.

roentgen irradiation without any appreciable effect on the evolution of the metastatic lesions in bone.

If we analyze the results for the different groups (Table VIII), we find that 2 of the 3 cases in Group I have benefited by irradiation; in Group II, 8 (Cases I, II, IV and VII) out of 9, although in Group III, only 5 patients out of 11 (Case VI) obtained some degree of improvement. Complete palliation often is not possible because of the widespread disease in this group. The patients classified in Group II responded better than those in the other groups, since 4 of 9 were not only relieved of their pain but also showed roentgenographic evidence of bone repair.

Fig. 6. Case V. Extensive osteolytic-osteoblastic changes involving the thoracic cage, spine and shoulder girdle. Roentgen therapy was of no avail.

Table VIII

DEGREE OF PALLIATION EFFECTED BY ROENTGEN THERAPY

(23 Cases)

	No. of Cases					Apparent Survival in Months
	Group I	Group II	Group III	Total	Per Cent	
None	1	1	6	8	34.8	9.3
Subjective improvement	1	4	4	9	39.1	13.6
Subjective and objective improvement	1	4	1	6	26.1	17.5
Total	3	9	11	23	100.0	

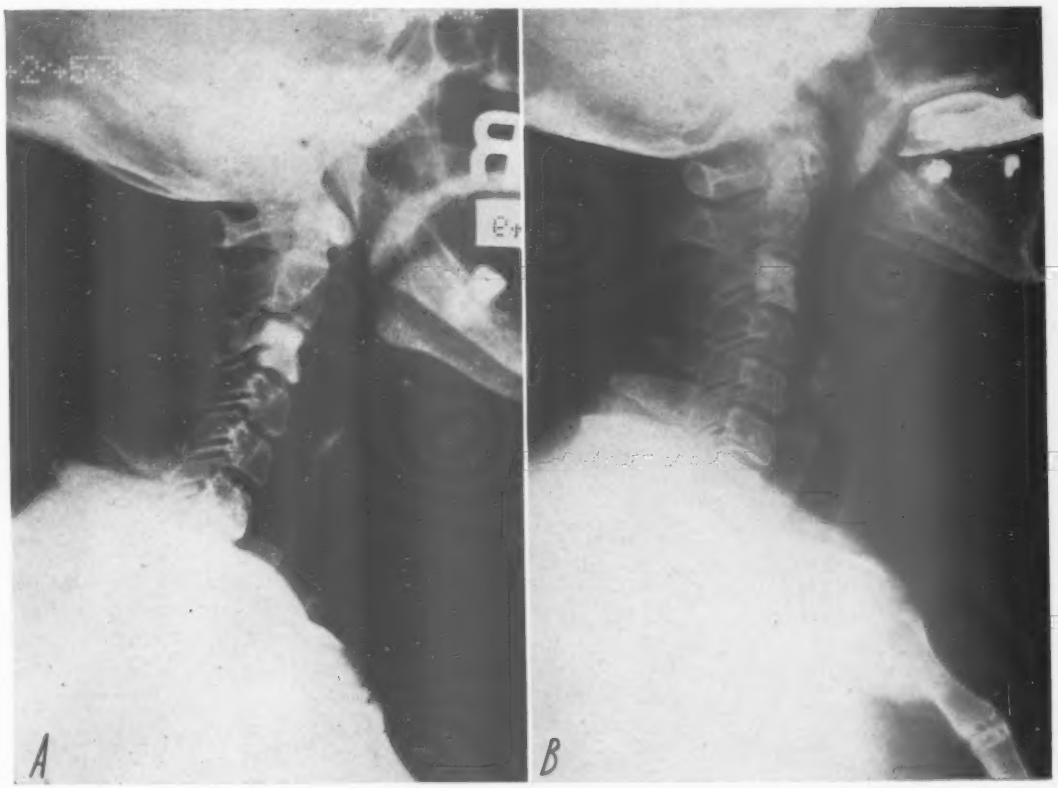

Fig. 7. Case vi. *A*, May, 1939. Third cervical vertebra initially showing a pure osteoblastic appearance. Patient had been complaining of occipital pain for a year. *B*, March, 1941. Partial regression of osteoblastic reaction with some reorganization of bone trabeculae, following five series of roentgen treatments.

CASE REPORTS

Case i. Mrs. M. P., aged seventy-two, found a lump in her right breast in July, 1938. Radical mastectomy on October, 1938, revealed carcinoma solidum scirrhous with involvement of axillary glands (Group ii). Postoperative roentgen therapy of breast (3,500 r) was given. Pain in both iliac bones and right hip in April, 1941, when roentgenograms showed a large osteolytic lesion in right ilium and other lesions in dorsolumbar vertebrae and right femur. Roentgen irradiation with 6,800 r to right ilium induced complete relief of pain in less than two weeks. Cutaneous metastases (breast) in October, 1941, were treated locally with radium. Films in January, 1942, demonstrated marked bone repair in right ilium, but extension of metastases to ribs, dorsolumbar spine and left femur. Irradiation of spine and left femur again afforded relief of pain. Although invalided, she was moderately comfortable from July, 1942, until her death on November 21, 1942.

Case ii. Mrs. A. H., aged forty-four, discovered a small nodule in the left breast in June, 1937. Radical mastectomy without dissection of axilla was done a month later, followed by postoperative roentgen therapy to the breast area, and irradiation of the ovaries to induce an artificial menopause. Pain in the left hip preceded by several months the demonstration of an osteolytic lesion in the left acetabulum in April, 1940. A total dose of roentgen radiation of 5,450 r afforded complete relief of pain. A roentgenogram made in October, 1940, showed bone repair and changes to the osteolytic-osteoblastic type. However, by June, 1941, progressive increase in density of the left ilium to a definite osteoblastic character was accompanied by the development of other metastases in the lumbar spine and left femur. On October 2, 1941, without evidence of any local recurrence in the breast area or return of pain, she died of hepatic metastases after being in bed for only two weeks.

Case III. Mrs. A. T., at the age of thirty-seven, had a radical mastectomy in 1929 for cancer of the left breast. In November, 1938, and January, 1939, she was treated surgically for recurrences in the scar. Later, in March 1941, the first skeletal metastases were found in the ribs and dorsal vertebrae with partial collapse of the fourth dorsal. The bone lesions were osteolytic in type, becoming osteoblastic after irradiation. Pain developed in the right knee in May, 1939, at which time a roentgen examination revealed an area of marked destruction of bone in the proximal half of right femoral shaft. This lesion was irradiated with a dosage of 1,500 r, and pain disappeared completely. Seven months later roentgenograms made elsewhere showed complete repair and healing of that lesion. Other skeletal metastases have been treated from time to time. She is still living and comfortable, four years after the first skeletal metastasis was found (sixteen years after operation), in spite of other cutaneous recurrences over the sternum.

Case IV. E. C., female, unmarried, at the age of forty-two had a tumor in right breast for three years before a radical mastectomy in March, 1936 (Group II). Pain in hips on standing came on six months later, and roentgen evidence of multiple osteolytic lesions in the pelvic bones was found. Roentgen therapy (4,000 r) induced early and complete relief of pain followed by complete repair with marked osteoblastic reaction by May, 1937. In February, 1938, further involvement was found in the dorsolumbar spine, especially osteolytic-osteoblastic in the third lumbar. The fourth dorsal was showing signs of collapse and presented the osteoblastic type of lesion. Roentgen therapy again caused subjective and objective improvement. Patient died with general carcinomatosis, including cerebral metastases, on February 17, 1939, having had intractable pain since October, 1938.

Case V. Mrs. V. S., at the age of thirty-one, December, 1937, felt a small tumor in her left breast. Second small mass in April, 1938. Preoperative roentgen irradiation (6,000 r) after the latter, and radical mastectomy was followed sixteen months later by constricting thoracic pain and cutaneous metastases. Extensive osteolytic-osteoblastic lesions were present in the bony thorax and shoulder girdles. No improvement of any kind was afforded by the irradiation. Death occurred December 31, 1939.

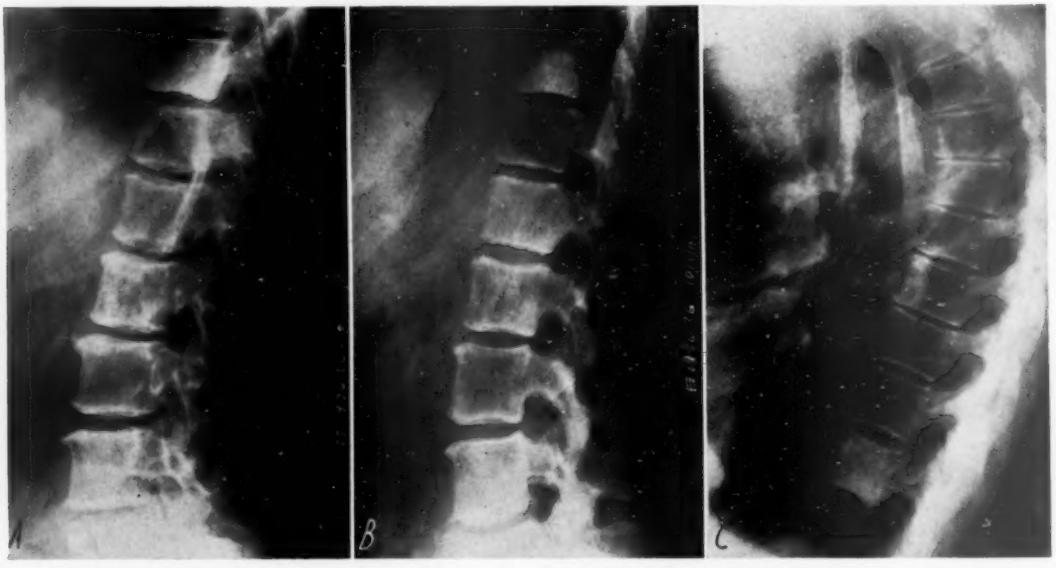

Fig. 8. Case VI. *A*, November, 1940. Osteoblastic type of lesion in the twelfth dorsal vertebra and osteolytic process in second lumbar. *B*, March, 1941. Following the administration of 1,950 r, there is now evidence of remarkable bone repair and reorganization of trabeculae in second lumbar. *C*, March, 1941. The twelfth dorsal vertebra also responded to treatment, as is evident from partial regression of the initial osteoblastic reaction.

Fig. 9. Case vii. *A*, September, 1940. Osteoblastic lesion in proximal end of right femur treated with roentgen irradiation (4,100 r). *B*, March, 1941. Decreased density and normal character of trabeculae indicating bone repair.

Case vi. Mrs. J. McR., then aged forty-four, first noticed a tumor in her left breast. In May, 1939, she first consulted the Outdoor Clinic for headache and occipital pain of one year duration. No lesion was found in the skull, but the third cervical vertebra was markedly osteoblastic. The breast tumor was treated with roentgen irradiation only, as the tumor was considered inoperable. Roentgen therapy to the cervical spine temporarily relieved the pain. Recurrence of the pain required multiple series of treatments. Two years later the third cervical was smoother in outline and not as dense. In November, 1940, she complained of lumbosacral pain, and an osteolytic lesion of the second lumbar as well as an osteoblastic lesion of the twelfth dorsal was found. Irradiation to the dorsolumbar area relieved the pain, and by March, 1941, there appeared to have been complete repair and healing in the second lumbar, while the twelfth dorsal had decreased in density and showed better texture. She died on June 30, 1941, exact cause unknown.

Case vii. Mrs. B. M. had a small mass in the right breast in 1931, at the age of thirty-eight. A radical mastectomy was performed a month later. In 1938 a cutaneous recurrence was excised and the region irradiated. Pulmonary metastases developed in June, 1940, and were treated by roentgen irradiation, with improvement. An osteoblastic lesion of the right femur appearing in September, 1940, with pain, was given roentgen therapy (4,100 r), followed by complete relief of pain. Bone repair in the nature of decreased density and more normal character of trabeculae had been achieved by March, 1941. She died in September, 1941, exact cause unknown.

Case viii. Mrs. U. B. first noticed the eczematoid appearance of the skin over the left breast about August, 1934, at the age of fifty-five. This ulcerated six months later. In December, 1936, when she first consulted her physician, the tumor was large and considered inoperable. Biopsy confirmed the diagnosis of

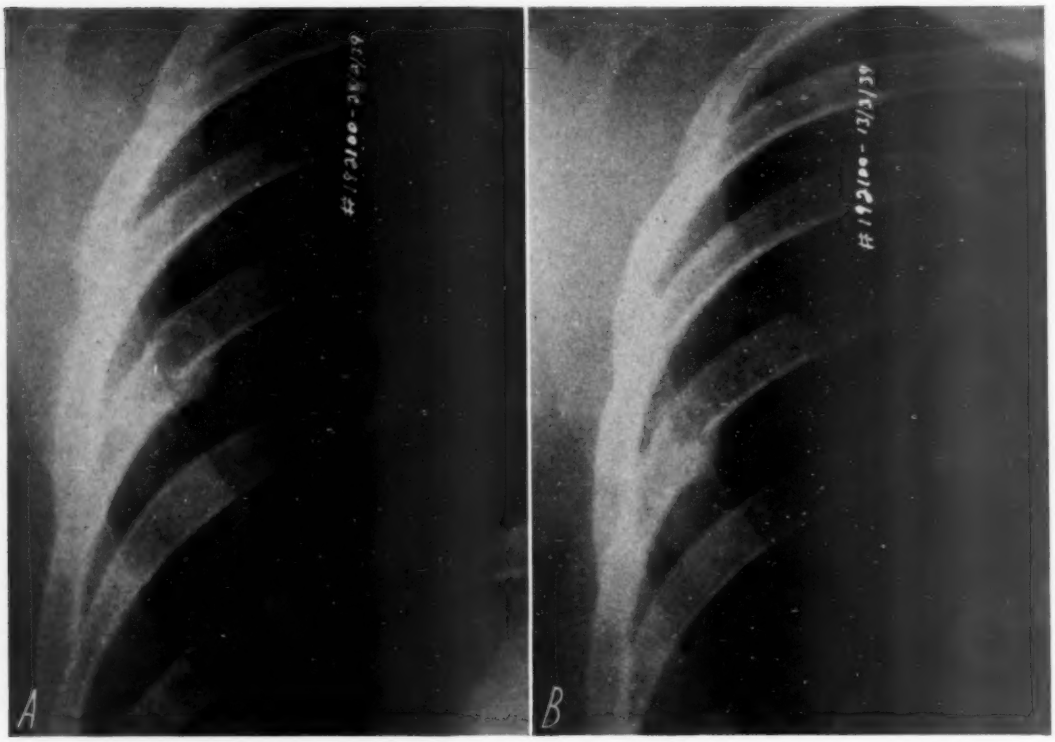

Fig. 10. Case VIII. *A*, February 28, 1939. Roentgenogram showing early repair of a pathological fracture of the sixth right rib, which occurred in January, 1939. Roentgen therapy to right thorax (2,700 r). *B*, March 13, 1939. Healing is progressing rapidly with formation of an exuberant callus.

carcinoma (carcinoma solidum). The local tumor was treated with both radium and roentgen irradiation. In September, 1937, she complained of pain in the right hip. An osteolytic metastasis in the right femur was found, and subsequently given 6,000 r. Later the pelvic bones, vertebrae, ribs and left humerus showed metastases. Pathological fracture of the right sixth rib occurred in January, 1939, at the same time as pleural metastases. Irradiation of the right thorax (2,700 r) induced a good healing of the fracture. She died in July, 1939, having had constant pain and distress in the terminal week.

SURVIVAL WITH SKELETAL METASTASES

An attempt has been made to establish the survival rate in months for the various age groups, first, from the apparent onset of cancer, second, from the time of treatment of the primary tumor, and third, from the time of appearance of metastases to bone.

It seems that the age period cannot be used as a prognostic base for survival either from the time of any form of treatment of the primary tumor or from that of the appearance of secondary lesions in bone. Also, the lapse of time between the apparent onset of the tumor in the breast and the application of any form of treatment of the primary tumor does not offer any indication as to the probable survival after the demonstration and treatment of skeletal metastases.

Table IX

Decade	Survival in months from: Onset of Primary Tumor	Treatment of Primary Tumor	Appearance of Metastases
20–30	33.0	18.0	12.5
30–40	53.1	39.8	9.6
40–50	65.5	31.3	17.2
50–80	55.2	45.2	9.0
Average survival	52.9	35.4	13.6

Some further interesting information may be gained from the data given in Table IX. The average survival from the appearance and treatment of skeletal metastases for all cases indiscriminately is 13.6 months. Individual survivals range from between three and thirty-three months. The mean survival of the patients who were in the forty to fifty decade in 17.2 months. This figure is obviously higher than in any other age period. In view of this potential increased survival period, should such patients with bone metastases from carcinoma of the breast be abandoned to their fate without benefit of such relief and palliation which is available to them?

TABLE X

SURVIVAL IN MONTHS IN VARIOUS CLINICAL GROUPS

Group	Interval between Onset of Primary Tumor and Metastases	Survival with Skeletal Metastases
I	18.3	7.4
II	37.7	15.2
III	35.5	14.6

The average survival in patients of the twenty to thirty age period was 12.5 months, which I am inclined to believe is somewhat high for that particular group. That may be due to the fact that we have only 2 patients falling in that decade of life, one of them having survived for twenty-two months. Lenz and Freid, however, believe that the prognosis is not necessarily grave in young individuals. Their figures, as ours noted above, suggest that the survival period with skeletal metastases depends more on the degree of malignancy as established from the histopathological study of the primary tumor and its metastases than on the age of the patient.

As we have already mentioned above, there is a certain relationship as to the interval between the appearance of the primary tumor and that of bone metastases, for the various groups. Such parallelism, namely, the longer that interval the longer the survival, exists in an analysis by stage of disease as well.

One may wonder to what extent the use of roentgen therapy may have contributed to lengthening the period of survival as well as to producing subjective or objective improvement. That could be established only by comparing a series of unirradiated cases. We do not have a comparable series of unirradiated cases. Nevertheless, let us assume that the efficiency of roentgen therapy may be expressed in terms of survival. Then Table VIII clearly demonstrates that the longer the survival, the better the results. Therefore we feel that we should be entitled to conclude that the use of roentgen irradiation in skeletal metastases is beneficial to the patient and may prolong life. However, Geschickter and Copeland[6] showed that the use of roentgen therapy was responsible for an increase of survival ranging from 6.5 to 22 months, depending upon the form of treatment applied to the primary tumor.

PATHOLOGICAL FRACTURES

Pathological fractures of vertebrae, ribs, femur and humerus were observed. According to Copeland, the rate of incidence of such fractures is 15.0 per cent, the femur being involved in 13.0 per cent of the cases. Lenz and Freid found a rate of incidence of 26.0 per cent, with predominance in femur and humerus. In our series, pathological fractures were discovered in 11 cases, or 45.8 per cent. Vertebral collapse stands well at the top of the list with 7 cases. Many of the vertebral and rib fractures seemed to have consolidated following moderate doses of roentgen therapy, i.e. about 1,500 r. We believe that conservative dosage is indicated in order not to impair in any way bone consolidation. The usual orthopedic supports must be used in conjunction with roentgen irradiation.

We have endeavored in this study to discuss skeletal metastases from cancer of the breast from every angle without losing sight of the disease as a whole. Every possible factor which we thought might improve diagnosis or establish prognosis and direct treatment has been judiciously analyzed

and weighed. Finally, all the information which could be obtained from this collection of data and used as a directive has been linked in a logical sequence in the form of conclusions.

CONCLUSIONS

1. In this series of 24 cases of cancer of the breast with unquestionable skeletal metastases, 87.5 per cent belong to the clinical Groups II and III. Skeletal metastases very seldom occur unless there has been invasion of the axillary glands and the corresponding lymphatics.

2. As skeletal lesions were the first metastases to be found and the only ones demonstrable in 62.5 per cent of our cases, these must be looked for systematically as well as pulmonary metastases before any operation on the primary tumor. Examination for that purpose must be carried out clinically as well as roentgenographically. Subsequently, as the patient reports for regular follow-up examination, repeated search for metastases to bone must be made, particularly if the patient is complaining of so-called "neuralgic" or "rheumatic" pains. In view of the rate of incidence of metastatic lesions in certain bones, the roentgen examination of thoracic cage, lumbosacral spine and pelvis, including the upper femora, is especially indicated for investigation purposes.

3. The effect of possible dissemination of metastases by vigorous or careless handling of malignant tumors, their recurrences or metastases, especially during clinical examination or operative procedures, has not been discussed. However, we wish here to introduce a warning against such occurrences.

4. The age factor does not seem to be of any significant importance in relation to the incidence or degree of malignancy of metastases to bone in general. The rate of incidence of such metastases increases or decreases as the usual rate of incidence of primary cancer of the breast in the various decades.

5. The mean interval between the appearance of the primary tumor and that of the skeletal metastases in our series was thirty-four months, i.e. about three years, except for the age group twenty to thirty where that interval is but one-half as long. It is important to consider that the longer that interval, the longer the probable survival period.

6. At least 75 per cent of the bone lesions have an osteolytic character when first discovered. An osteoblastic lesion probably indicates a long standing or slowly growing skeletal lesion. In our series, a change from the osteolytic to the osteoblastic type, which we interpret as the result of depression or death of the neoplasm and repair by the remaining bone, has been induced by irradiation.

7. The prognosis in skeletal metastases from cancer of the breast is not quite as poor as it might seem. The average survival for the whole group of patients is 13.6 months, the maximum thirty-three months. As long as the skeletal metastases remain the only demonstrable lesion, the immediate prognosis is relatively good, but the development of other metastases, particularly in the lung or pleura, definitely shorten the survival period.

8. Under roentgen therapy, 66.0 per cent of the cases have subjective improvement; 26.0 per cent show also objective response to irradiation, the average survival period for that latter category increasing to eighteen months, the maximum being twenty-nine months.

9. Patients belonging to Group III should not be operated upon. Both the primary and secondary or metastatic lesions should be treated with irradiation only.

10. Finally, no case is so hopeless as to warrant discard without a trial of therapeutic roentgen irradiation. Results are oftentimes astonishingly good, even though they may not be permanent.

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TREATMENT OF HEMANGIOMAS WITH ROENTGEN RAYS*

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THE treatment of hemangiomas by roentgen rays is not new. In 1897 Jutassy found that their destructive effect upon the radiosensitive intima of the blood vessels faded and flattened the lesions.[12] Although the action of roentgen rays and rays from radium on individual cells are probably identical, radium has been used almost universally in the treatment of hemangiomas. Roentgen rays have not been utilized because of technical difficulties, such as the danger of electric shock, and the danger of overexposure due to inexact measurement of dosage. Since practically all therapy equipment is now shock-proof, and since sensitive and accurate measuring instruments are available, former objections to roentgen therapy no longer apply.

About five years ago we began to use unfiltered roentgen rays for the treatment of vascular nevi with good results. We now use only two techniques. In the first, we use unfiltered rays produced at 135 kv., and 18 cm. anode-skin distance. This technique is used for the treatment of all lesions thicker than 0.5 cm. and smaller than 3 cm. in diameter. About 30 per cent of the skin dose is absorbed by the first centimeter of tissue. In the second technique, we use unfiltered rays produced at 80 kv., and 15 cm. distance. This technique is used for the treatment of all flat lesions and of thick lesions whose diameter is greater than 3 cm. About 53 per cent is absorbed in the first centimeter.

The distribution of the rays produced by the two techniques, and the variations in skin dose with various sizes of field are shown in Tables I and II, respectively. The measurements upon which the tables are based were made with a small (4 by 4 by 4 mm.) ionization chamber in a small (10 by 10 by 10 cm.) water phantom. Our depth dose percentages are somewhat higher than those recently published by Braestrup.[5]

Hemangiomas are the most common neoplasm in infancy,[15,16] usually appearing within the first two or three weeks of life. Their cause is unknown. Lister[10] reports that 76 of 77 strawberry nevi, if untreated, disappear in the first five years of life. He believes growth is necessary during the first year to obtain a spontaneous cure. Growth did not occur in the lesion that failed to disappear. Many believe that spontaneous cure is relatively uncommon.

Clinically we divide hemangiomas of the skin into five types:

1. *Hemangioma simplex.* This is a blotchy area that occurs on the back of the neck in a high percentage of newborn infants. These blotchy areas usually disappear without treatment after several months or a few years.

2. *Capillary hemangioma.* We divide this type into two different kinds of lesions, the bright red, non-elevated nevus from which the color can be easily pressed out, and the dark red or purplish lesion from which it is difficult to press out the color. The first type of lesion usually responds to treatment. The second type, often called nevus flammeus or port wine stain, responds poorly to any kind of therapy. This lesion should probably not be treated by irradiation unless treatment can be given within the first month of life.

3. *Hypertrophic hemangioma, or "strawberry birthmark."* This is characterized by an elevated, slightly irregular, bright red lesion which usually grows faster than the infant. It responds well to irradiation because there is marked overgrowth of the sensitive endothelial cells. These lesions

* Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.

Table I

Size of field in cm.	1×1	2×2	3×3	4×4	5×5	7.5×7.5
Dosage (in air)	100 r	100 r	100 r	100 r	100 r	100 r
Dosage on skin	102 r	104 r	109 r	115 r	116 r	119 r
0.5 cm.	92	100	101	103	107	110
1.0 cm.	74	78	82	84	88	89
2.0 cm.	47	52	59	63	64	66
3.0 cm.	34	37	40	45	47	51
4.0 cm.	26	29	31	34	37	40
5.0 cm.	20	23	25	28	30	32

Surface and depth doses in roentgens per 100 r in air.
(135 kv.; 5 ma.; 18 cm. anode-skin distance; filter, none; half-value layer 1.1 mm. Al; intensity, 300 r per minute in air.)

may be mixed with the cavernous type, forming large, protruding masses, or with lymphoid and fibrous tissue.

4. *Cavernous hemangioma.* This type has large blood spaces which involve the skin and deeper structures or may be confined only to the tissues beneath the skin. A soft, bulging mass is present which often has a reddish or bluish color. The lesion can sometimes be made to disappear when continuous pressure is applied for a few minutes. These lesions are sometimes associated with hyperplasia of fatty or fibrous tissues, because after irradiation the color disappears but there is only partial disappearance of the bulging mass.

Table II

Size of field in cm.	1×1	2×2	3×3	4×4	5×5	7.5×7.5
Dosage in air	100 r	100 r	100 r	100 r	100 r	100 r
Dosage on skin	101 r	103 r	105 r	106 r	108 r	110 r
0.5 cm.	60	65	69	73	75	78
1.0 cm.	43	46	50	54	56	58
2.0 cm.	23	27	29	31	32	34
3.0 cm.	13	16	18	20	21	22
4.0 cm.	9	11	13	14	15	16
5.0 cm.	6	8	9	10	11	12

Surface and depth doses in roentgens per 100 r in air.
(80 kv.; 10 ma.; 15 cm. anode-skin distance; filter, none; half-value layer 0.57 mm. Al; intensity, 267 r per minute in air.)

Fig. 1. R. B., aged eight weeks. *A*, elevated, ulcerated, hypertrophic hemangioma on neck and shoulder. Diameter 6 cm. *B*, eleven months later, after two roentgen treatments to entire area and four roentgen treatments to smaller areas. Total dose 2,600 r.

5. *Spider nevi.* This lesion consists of a network of small, dilated vessels arising from one or more central vessels. Pressure by a small magnifying glass usually identifies the feeders. They are best destroyed by inserting a fine cambric needle into the central vessels and then touching the needle with a coagulating current until a slight bleaching occurs around the needle. This is done without local anesthesia and may have to be repeated two or three times before the lesion is entirely destroyed. The procedure is painful.

Irradiation of hemangiomas by roentgen or radium rays produces a gradual shrinking and obstruction of the vascular spaces. The degree of sensitivity depends upon the type of endothelial cells, the character of the surrounding stroma, and the size of the vascular spaces. We have found that, if treatment is started soon after the appearance of the hemangioma, while it is more sensitive, less irradiation is necessary and better cosmetic results are obtained. According to Ward and Covington,[14] and others,[2,8,11] the radiosensitivity of hemangiomas decreases in direct proportion to the age of the infant. Children older than three or four years should be treated very cautiously because of the danger of overdosage. Many of our cases treated within the first two or three months of life required only one or two treatments. If the lesion is allowed to grow without treatment, it may reach considerable size, become ulcerated and infected. When this occurs any type of treatment results in considerable scarring.

We have found roentgen irradiation to be much more satisfactory than other methods of treatment which we have used. We can treat the lesions with roentgen rays more homogeneously and get a more even disappearance of the color and tumor mass. This is especially true when the lesions are of such size that the radium applicator has to be applied to more than one area. Much larger areas can be treated with roentgen

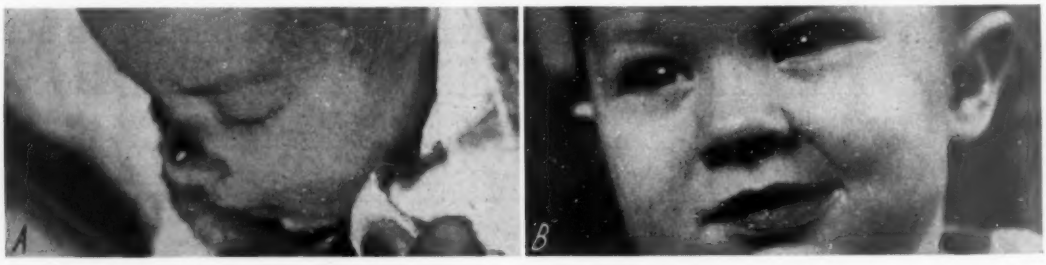

Fig. 2. W. F., aged seven weeks. *A*, elevated, bluish-red, cavernous hemangioma on nose. *B*, nine months later, after three roentgen treatments. Total dose 1,300 r.

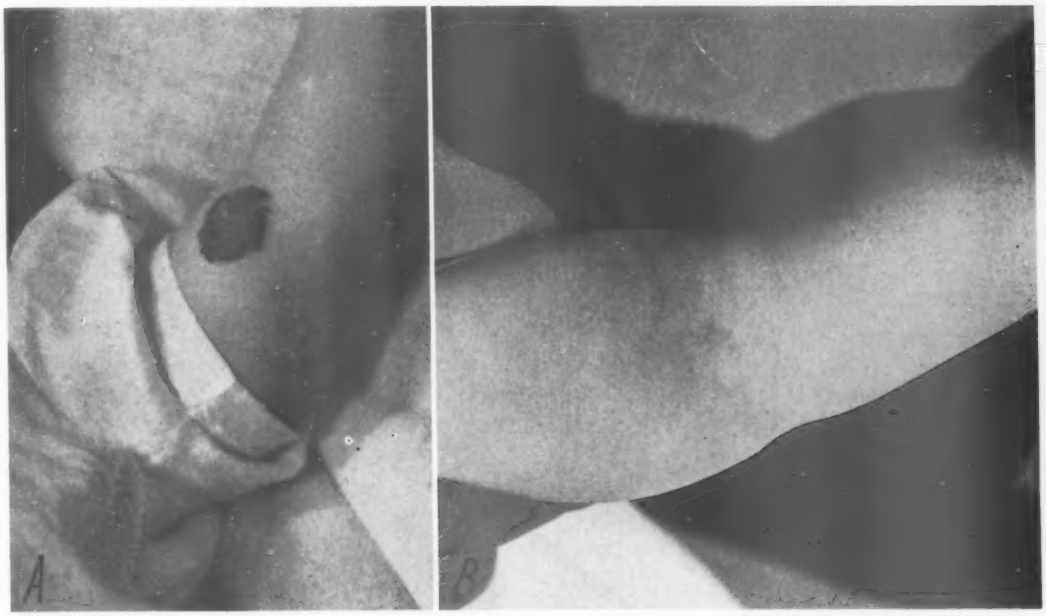

FIG. 3. J. T., aged six months. *A*, elevated, hypertrophic hemangioma on left forearm. Diameter 3 cm. *B*, eight months later, after three roentgen treatments. Total dose 1,400 r.

rays at one time than with radium. The treatments are very short, lasting from one to three minutes, depending upon the technique used. The infant can be held or strapped in position for the treatments. Perhaps the greatest advantage of roentgen rays is their availability. In Iowa roentgen therapy is available in many more places than radium. We believe this also applies to a large part of the United States. Another advantage is the ease and the cheapness of treatment. The average cost is from three-fourths to one-half less than radium. We have had no experience in treating hemangiomas with the contact roentgen therapy method. From reports in the literature excellent results are obtained.[1,6,8,9]

Our method of treating hemangiomas consists of cutting an opening in lead foil the size and shape of the lesion. Occasionally the opening is made slightly larger in order to include subcutaneous vessels and the growing edge of the lesion. From 300 to 600 r is given at one treatment, depending

FIG. 4. N. C., aged ten and one-half months. *A*, bluish-red, cavernous hemangioma on palm of left hand. Diameter 3 cm. *B*, eight months later, after five roentgen treatments. Total dose 2,500 r.

upon the size and location of the lesion. If the hemangioma is 1 cm. or less in diameter, and there is no danger of injury to the subcutaneous structures, 600 r is given. When the lesion is 5 cm. or more in diameter, from 300 to 400 r is used. We have had very few noticeable skin reactions with these doses. An occasional mild erythema occurs at the edge of the lesion when the larger dose is used. The patients are seen in one month, and if there has been no response to the treatment and if no erythema is present, they are treated again. When the lesions are fading and flattening, we wait at least one or two months more before continuing treatment. If the infant is less than two or three months of age, it is surprising how often only one or two treatments are needed to produce an excellent result. I am convinced that if all hemangiomas were treated as soon as discovered there would be very little scarring or ulceration. In some of the large hemangiomas loss of color is more rapid in the center. When this occurs, lead is cut out and placed in the central area for part or all of the succeeding treatments.

Unfortunately, the treatment of vascular nevi is not without danger,[3,4,7,13] as there are various complications and residuals. Great care should be taken in the treatment of lesions near epiphyses and glandular structures. As little as 400 r delivered to the epiphyseal plate will produce a delay of bone growth. It is usually better to treat hemangiomas in the region of the testes by some other method than irradiation. Overdosage in any area will produce blistering, possibly ulceration, and infection with increased scarring. Large total doses may result in growth disturbance, in telangiectasia, or in skin atrophy. Loss of hair should be considered, although we have had very little permanent loss of hair in treating lesions of the scalp early in infancy. It is not uncommon to find that the hair comes in a darker shade after epilation.

From December, 1939, to January, 1944, we treated with unfiltered roentgen rays 129 cases of hemangiomas in infancy and childhood with better cosmetic results than we were able to obtain with radium or any other method. We have classified our results into four groups:

Those with a minimum of scarring or with complete disappearance of color and tumor mass were considered excellent. These lesions are not noticeable at the usual conversation distance. This result was obtained in 87 of the 129 cases.

Good results were obtained in 27 cases. These had either a more noticeable scar or a few residual vessels but there was complete disappearance of the tumor mass.

Fair results were obtained in 8 cases. These consisted of a residual tumor mass, some color and scarring.

Poor results were obtained in 4 cases. One of these was a pigmented hemangioma which showed no response to treatment. The second was a nevus flammeus. The third was a large, mixed lymphangioma involving the right scalp, face and neck, and probably complicated by intracranial hemangiomas. The fourth poor result was probably due to overtreatment of the inner half of the proximal tibial epiphysis as there is delayed growth of the inner half of the tibia producing a slight genu varum. This patient received two treatments of 450 r each, with an interval of one month. We have since used tangential irradiation with good results in lesions near the epiphyseal plate and without apparent epiphyseal injury. We recently observed some of the earlier cases and many of the areas treated have improved in appearance over a period of four or five years. Two cases involving the entire upper eyelids were treated with excellent results. A lead shield was placed in the conjunctival space to protect the eye.

The hemangiomas seem to respond more rapidly to roentgen irradiation than to treatment with radium, possibly because they are now treated at a much earlier age. We have not had the skin reactions with roentgen irradiation that were occasionally observed when we used radium. These reactions were, perhaps, due to improper construction of the radium applicators so that

uneven distribution of radiation was obtained.

CONCLUSIONS

In our experience unfiltered roentgen irradiation, using 80 to 135 kv., has proved superior to other methods of treating hemangiomas of the skin because the lesions can be treated more homogeneously, more rapidly, more economically, and because larger areas can be treated at one time. We believe equally good results can be obtained wherever roentgen therapy is available.

I wish to express my appreciation to Dr. A. W. Erskine for his help and advice in the establishment of the techniques and in the preparation of the depth dosage table.

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DISCUSSION

Dr. Rollin H. Stevens, Detroit, Mich. I should be inclined to question the advisability of Dr. Prouty's second technique—use of the unfiltered rays at 80 kv. at 15 cm. distance for all flat lesions whose diameter is greater than 3 cm., about 47 per cent being absorbed in the first centimeter. It would seem to me it would be better to reserve that treatment for the smaller lesions and use the first technique he mentioned for the larger ones. I am a little afraid of too much irradiation reaction in those cases.

He claims that the advantages over radium are that there are more of the roentgen rays that are homogeneous, the treatment is shorter and less expensive. If the treatment is so applied that it covers the entire nevus, including the border and a millimeter or two beyond, the results of the treatment should be as homogeneous with radium as with roentgen radiation.

One difficulty in applying radium is to get the radium skin distance exactly the same in all parts of the lesion. As has been pointed out by Strandqvist, an increase of 2 mm. in the distance reduces the intensity to 40 per c nt. That is quite a substantial reduction and may account for lack of homogeneity in some of the cases treated by radium because of variation in distance from radium to skin.

When moulded compounds are used as applicators it is almost impossible to keep the distance of the radium needle used in the applicator within the limits of 2 mm. Hence, homogeneity of action is lost,—and Strandqvist has developed applicators of glass with channels in the center to receive the radium needle. They are exactly 5 mm. in diameter. If any number of these are placed side by side, the distance from the axis of one needle to the other

and to the skin is also exactly 5 mm., these applicators being placed directly on the skin.

We used these glass capsules for some time after reading Strandqvist's paper in 1939, but in the last two years we have had some applicators made of lucite for single needles and rows of two, three and four in one applicator. We have platinum coverings over our needles to make a 0.5 mm. platinum filter. Up to the present we have used only gamma rays since we have been using these applicators.

Formulae for working out the dose based on Sievert's tables are provided. From these we have had Dr. Gratzek, formerly on our staff, prepare a dosage chart. We cover the lesion with one or two rows of capsules, select the number of roentgens we think a case may require, consult our chart and get the time factor required. Strandqvist uses 8 or 10 mg. needles in the capsules. We generally use 5 mg. needles because we have more of them than of the 10 mg. Of course they require twice the time, worked out by Strandqvist's charts. In this way we are able to give fairly accurate homogeneous doses of radium.

We have no doubt just as good results may be accomplished with roentgen irradiation and with less trouble, except I do not feel we can easily keep a child still under that treatment long enough to get an exactly limited and homogeneous irradiation.

We use doses of 500 to 800 r, depending on the age of the child, the depth of the lesion, its proximity to the epiphyses, and other important structures.

Dr. U. V. Portmann, Cleveland, Ohio. At the 1940 meeting of the Radiological Society of North America I discussed a paper on roentgen therapy of hemangiomas given by Drs. Fred M. Hodges and Raymond A. Berger of Richmond, Virginia. I showed photographs of the results of treatment of a very large cavernous hemangioma involving the whole forearm and most of the hand of a child. This was treated with radium, and the "spottiness" that remained was given contact roentgen therapy with satisfactory results as shown by these photographs.

I warned the parents when treatment was started that the affected forearm might be shorter. This occurred, as shown by the photograph and roentgenogram of both forearms taken three years later. There is evidence of delay in development of ossification centers of the metacarpals, the radius, and the ulna. Although the forearm is shortened, there is no apparent interference with function.

Another case may be of interest. The photograph shows a cavernous hemangioma involving the entire left side of the face including the eyelids. The child also had a large hemangioma on the back of the neck, harelip, and cleft palate. I hesitated to treat this baby but finally did so on the insistence of the parents. Only contact roentgen therapy was given to the face. The physical factors were 50 kv., 2 ma., 2.1 cm. focus-skin distance, filter 1.0 mm. Al. Usually several areas were given 200 to 300 r each at monthly intervals. The hemangioma on the back of the neck was given the same dosage with 200 kv. and filter equivalent to half-value layer of 0.9 mm. Cu. The next photograph shows the remarkable improvement that has taken place in the past year and one-half. Treatment will be continued.

Dr. Prouty (closing). In reply to a question regarding telangiectasis, we had 1 or 2 cases early in the series when we were using larger doses more frequently. We did not use compression in the treatment of any of these lesions.

In reply to Dr. Stevens' question as to why we use 80 kv. in the treatment of superficial and large lesions it is because we do not want a large depth dose. In infants the distance from the skin surface to vital structure is very little, especially the bony structures near the epiphyses.

What I mean by a flat lesion is one with not more than 1 or 2 mm. elevation. If 135 kv. is used near the epiphyses, the depth dose percentage at 1 and 2 cm. is too great and there is danger of injury, resulting in a disturbance of bone growth.

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TUMORS IN ONE OF HOMOLOGOUS TWINS

HODGKIN'S DISEASE WITH PRIMARY SKELETAL MANIFESTATIONS*

By HERMAN CHARACHE, M.D.
BROOKLYN, NEW YORK

IN THE July, 1941, issue of this JOURNAL a report of tumors in one of homologous twins was made.[1] It was emphasized that "Were sufficient clinical material available, the study of homologous twins would seemingly contribute a great deal toward solving the genetic theory of cancer." In this report 2 cases of Hodgkin's disease were included. Two additional cases have since been found in the literature (Smith,[7] Macklin[4]). The latter case was mentioned in an excellent report on "Tumors in monozygotic and dizygotic twins" before the Seventh International Congress of Genetics at Edinburgh, Scotland, in 1939.

The case to be reported here is the fifth case of Hodgkin's disease in one of homologous twins. In addition, it presents very interesting findings; namely, skeletal involvement as shown by roentgenographic studies without any other clinical manifestation of Hodgkin's disease. The diagnosis was established by autopsy findings. Other cases of primary skeletal manifestation of Hodgkin's disease without clinical findings of the disease were reported by Priesel and Winkelbauer,[5] Krumbhaar,[2] Livingston,[3] and Schenck.[6]

CASE REPORT

P.T., a white female, aged five, one of homologous twins, was admitted to the Brooklyn Cancer Institute on January 6, 1940, with a history of pain in the right hip and right shoulder, fever, and loss of weight of ten weeks' duration.

Ten weeks previous to admission to the Brooklyn Cancer Institute, the patient developed pain in the right hip and had difficulty in walking. Shortly afterward she began to have pain in the region of the right clavicle. She became irritable, cried a great deal, lost her appetite, and began to lose weight. When the mother noticed that the child had developed a fever, she took her to a hospital, where a diagnosis of rheumatic fever was made. However, when roentgenograms revealed a partial destruction of the right ilium and right clavicle, she was transferred to our Institute for diagnosis and treatment.

FIG. 1. Hodgkin's disease in one of homologous twins. (Healthy twin refused to take off shoes.)

The patient was born on May 23, 1934, full term, normal vertex delivery. A few minutes later her twin sister was born. Each weighed 3½ pounds. Both were kept in an incubator for a

* From the Brooklyn Cancer Institute, Brooklyn, N. Y.

A *B*

FIG. 2. Postmortem roentgenogram showing destruction of distal end of ilium (*A*) and clavicle (*B*) by Hodgkin's disease.

FIG. 3. Hodgkin's disease of skull.

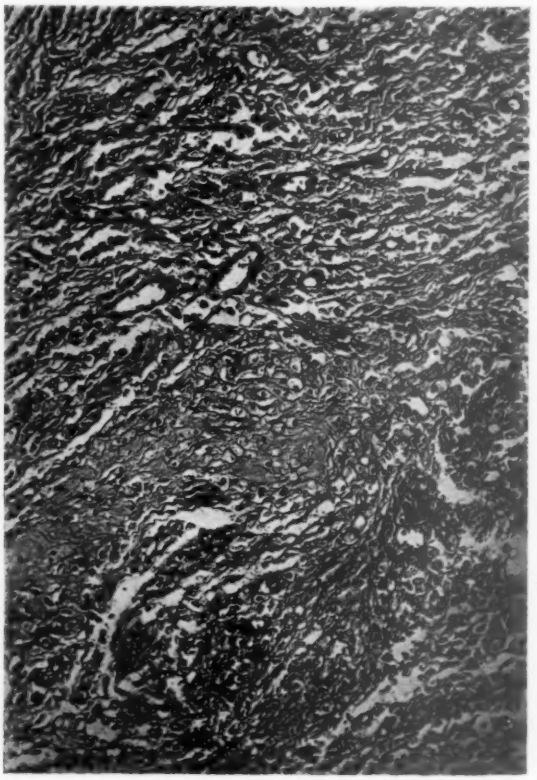

FIG. 4. Photomicrograph (140x) showing Hodgkin's disease of the ilium.

long time. When the milk formula did not agree with one, it did not agree with the other. When they grew older, both had the same likes and dislikes regarding food. Both had the same bowel and urinary habits. Both children had measles at about the same time. When the patient developed whooping cough, her twin sister was taken to her grandmother's; however, she too developed whooping cough.

The parents are in good health. Their blood Wassermann reactions were negative, and there is no history of cancer in the family.

Physical examination revealed a pale, undernourished five year old child, acutely and chronically ill. Her temperature varied from 98° to 103° F., pulse 90 to 135, and respiration 22 to 44. A few discrete pea-sized glands were found in the neck and inguinal regions. The heart and lungs showed no clinical evidence of a pathologic condition. The abdomen was somewhat distended; no masses were palpable. The liver and spleen were not palpable.

Urinalysis and the blood Wassermann reaction were negative. The blood count showed 3,820,000 red blood cells, with 72 per cent hemoglobin. The leukocyte count was 28,500, with 91 per cent polymorphonuclear leukocytes and 9 per cent lymphocytes. The blood chemistry revealed urea 7.6 mg., sugar 83 mg., calcium 11 mg., phosphorus 3.7 mg., phosphatase 13 units, cholesterol 185.1 mg., cholesterol ester 65.3 mg.

The entire skeleton was roentgenographed except the feet. The positive roentgen findings were as follows: Two cherrystone sized areas of rarefaction in the parietal region of the skull, rarefaction of outer half of right clavicle, and a round area of rarefaction measuring 1½ inches of the right ilium. Roentgen examination of the chest showed hypertrophy of the left ventricle; otherwise there was no sign of a pathologic condition. The intravenous pyelogram suggested a bulging of the outer surface of the right kidney.

The patient remained in the hospital for a month under supportive treatment. She received palliative roentgen therapy to the right hip and clavicle. Her general condition grew progressively worse, and she became moribund. On the morning of February 6 she was suddenly seized with severe air hunger. An emergency portable roentgen examination revealed the collapse of both lungs. She died shortly afterward.

An autopsy was performed by Dr. Herman Bolker. The anatomico-pathologic diagnosis was as follows: Reticulo-endothelial sarcoma (atypical Hodgkin's disease) of the thymus, cervical lymph nodes, and lungs, with secondary emphysema and bilateral pneumothorax, liver, spleen and bones. The sections were submitted to several pathologists, including Dr. James Ewing, who confirmed the diagnosis of Hodgkin's disease.

The patient's homologous twin is being observed at three-month intervals. Physical examination, including roentgenographic study of her skeleton and lungs, shows no evidence of any pathologic condition. She was last seen on August 24, 1944, four years and eight months after the onset of symptoms in the deceased homologous twin.

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EDITORIAL

AMPUTATIONS

AMPUTATION surgery has always assumed increasing importance in wartime because of the relatively common need for the removal of extremities destroyed directly by the missiles of war or indirectly through loss of blood supply, gas gangrene and other severe infections. The recent advances made in surgery, chemotherapy and supportive measures have largely overcome the dangers of infection, so that amputation is seldom indicated for infection alone. In military surgery, emergency amputations are performed under conditions which are often unfavorable, delay is frequently encountered and early evacuation must be observed. Under these circumstances all emergency amputations for severe trauma, infection or gangrene must be of the open type commonly known as a guillotine amputation. The indications for emergency amputation as well as for subsequent reconstructive surgery depend in many instances on careful roentgenological technique and interpretation. If properly done, such an amputation permits early closure of the stump by continuous skin traction. In selected cases, early secondary suture may be successful, but this should not be attempted unless these patients remain under observation. Secondary revision of the stump is required in most cases before a prosthesis is fitted. These various factors have all been taken into consideration in the establishment of the current policy for amputations in the United States Army.

Approximately 5 per cent of the major amputation cases have lost part of two extremities, less than one per thousand has lost part of three, and recently one quadruple case has occurred in Army combat casualties in this war. Fortunately, the more disabling amputations are less common, disability increasing in the following order: below the knee, above the knee, below the elbow and above the elbow.

Sites considered optimum for amputation are based upon experience and depend on the types of the prostheses available. While the general principles of amputation surgery are essentially the same throughout, there will continue to be a gradual evolution as new prosthetic devices are produced. This is particularly true with amputations near the major joints, including the ankle, knee, wrist and elbow. Standardization and improvement of prostheses have become a matter of national interest and importance with the result that civilian and military agencies have undertaken coordinated research and development. This effort is already bearing fruit and will achieve greater success in the near future.

The goal in amputation surgery is the restoration of function and not merely the amputation itself. This program requires the coordinated effort of all interested personnel including the surgeon, limb fitter, physical therapist, occupational therapist and those engaged in education, recreation and vocational rehabilitation. Finally, industry must employ and train the amputees to take their place among other employees. As a profession and as a nation, we are faced with a special challenge to enable the physically handicapped, of which the amputees constitute a large portion, to assume their place and responsibility in the world along with their fellow men. Experience has now shown that such a program is industrially safe and economically sound. Therefore, special care should be taken in surgical reconstruction, prosthetic fitting and training in order that we may achieve the maximum social and economic rehabilitation of the war amputee.

Norman T. Kirk, Major General,
United States Army,
The Surgeon General

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Items for this section solicited promptly after the events to which they refer.

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Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago.

Section on Radiology, American Medical Association
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: 1945, canceled.

Arkansas Radiological Society
Secretary, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: 1945, to be announced.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

Section on Radiology, California Medical Association
Secretary, Dr. Gordon G. King, 3700 California St., San Francisco 18, Calif.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

Radiological Section, Los Angeles County Medical Association
Secretary, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Brooklyn Roentgen Ray Society
Secretary, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N.Y. Meets monthly on fourth Tuesday, October to April.

Buffalo Radiological Society
Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

Chicago Roentgen Society
Secretary, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

Cincinnati Radiological Society
Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

Cleveland Radiological Society
Secretary, Dr. D. D. Brannan, 11311 Shaker Blvd., Cleveland 4, Ohio. Meets at 6:30 P.M. at Allerton Hotel on fourth Monday each month, October to April, inclusive.

Dallas-Fort Worth Roentgen Study Club
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meetings held in Dallas on odd months and in Fort Worth on even months, on third Monday, at 7:30 P.M.

Denver Radiological Club
Secretary, Dr. A. Page Jackson, Jr., 1612 Tremont Place, Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

Florida Radiological Society
Acting Secretary, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.

Georgia Radiological Society
Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

Illinois Radiological Society
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meets annually second Sunday in May.

Iowa X-Ray Club
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

Kentucky Radiological Society
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

Long Island Radiological Society
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

Louisiana Radiological Society
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

Michigan Association of Roentgenologists
Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

Milwaukee Roentgen Ray Society
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.

Nebraska Radiological Society
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

New Hampshire Roentgen Ray Society
Secretary, Dr. Richard C. Batt, Berlin, N. H. Four meetings a year.

Radiological Society of New Jersey
Secretary, Dr. H. R. Brindle, 501 Grand Ave., Asbury Pk. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

New York Roentgen Society
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Roentgen Ray Society
Secretary, Dr. Major Fleming, Rocky Mount, N. C. An-

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

nual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

North Dakota Radiological Society
Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

Central New York Roentgen Ray Society
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

Ohio Radiological Society
Secretary, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport.

Philadelphia Roentgen Ray Society
Secretary, Dr. C. L. Stewart, Jefferson Hospital, Meetings first Thursday of each month, October to May, at at 8:00 P.M., in Thomson Hall, College of Physicians, 21 S. 22d St.

Pittsburgh Roentgen Society
Secretary, Dr. L. M. J. Freedman, 4800 Friendship Ave. Meets 6:30 P.M. at The Ruskin on second Wednesday, each month, October to May inclusive.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary Dr. A.M. Popma, 220 N. First St., Boise, Idaho.

St. Louis Society of Radiologists
Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.

San Diego Roentgen Society
Secretary, Dr. Henry L. Jaffe, Naval Hospital, Balboa Park, San Diego, Calif. Meets monthly on first Wednesday at dinner.

San Francisco Radiological Society
Secretary, Dr. Carlton L. Ould, University of California Hospital, San Francisco 22. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. Asa E. Seeds, Baylor Hospital, Dallas, Texas. Next annual meeting, Temple, Texas, Jan. 17, 1945.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00–5:00 P.M., Room 301, Service Memorial Institute.

Virginia Radiological Society
Secretary, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

X-ray Study Club of San Francisco
Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly, third Thursday evening.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month at 4:45 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

Faculty of Radiologists
Secretary, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

Canadian Association of Radiologists
Secretary, Dr. J. W. McKay, 1620 Cedar Ave., Montreal, P. Q.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

South America

Sociedad Argentina de Radiologia
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

Sociedad Peruana de Radiologia
Secretary, Dr. Victor Giannoni, Apartado, 2306, Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión, Villalta, 218, Lima.

Continental Europe

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

CLINICAL CANCER TEACHING DAY

A Clinical Cancer Teaching Day will be held at the Homer Folks Tuberculosis Hospital, Oneonta, New York, on Wednesday, October 3, 1945. The Clinical Program from 2 to 4 P.M. will consist of "Clinical Demonstration and Discussion of Cancer Patients" by Drs. Milner, Stewart, Treves and Twombly. Following this, two papers will be given: "Ovarian Carcinoma" by Gray H. Twombly, M.D., Memorial Hospital, New York: "Cancer of the Breast" by Norman Treves, M.D., Memorial Hospital, New York. Dinner will be served at the Homer Folks Tuberculosis Hospital at 6:15. The evening meeting will be called to order at 7:30 and the following program will be given: "Carcinoma of the Bladder" by William A. Milner, M.D., Albany Medical College, Albany, New York; "Biopsy in Tumors" by Fred W. Stewart, M.D., Memorial Hospital, New York.

Advance reservations are required for the dinner and should be sent to Dr. Ralph Horton, Superintendent, Homer Folks Tuberculosis Hospital, Oneonta, New York.

CANCER TEACHING DAY

A Cancer Teaching Day will be held at the Governor Clinton Hotel, Kingston, New York, on Wednesday, October 17, 1945. The program will begin at 3:30 P.M., and the following papers will be presented: "Cancer of the Skin and Allied Tumors" by Earl D. Osborne, M.D., University of Buffalo School of Medicine, Buffalo, New York; "The Role of the Practicing Physician in the Care of Cancer" by Frederick S. Wetherell, M.D., Syracuse University College of Medicine, Syracuse, New York. Dinner will be served at the Governor Clinton Hotel at 6:30. At the evening meeting beginning at 7:30 the following papers will be given: "Cancer of the Prostate" by Charles B. Huggins, M.D., University of Illinois, Chicago, Illinois; "Biopsy in Tumors" by Fred W. Stewart, M.D., Memorial Hospital, New York.

Reservations for the dinner must be made in advance and should be sent to Dr. Frederick H. Voss, 69 Spring St., Kingston, New York.

CANCER TEACHING DAY

A Cancer Teaching Day will be held at the Auditorium, Albany College of Pharmacy, Albany, New York, on Thursday, October 18, 1945. The meeting will be called to order at 3:30 P.M. and the following papers will be given: "Cancer of the Head and Neck" by Hayes Martin, M.D., Memorial Hospital, New York; "Cancer of the Prostate" by Charles B. Huggins, M.D., University of Illinois, Chicago, Illinois. A buffet supper will be served at 6:30. The evening meeting will begin at 8:00 o'clock and the following papers will be presented: "Cancer of the Stomach" by George T. Pack, M.D., Memorial Hospital, New York; "Hormone Therapy and the Prevention of Gynecologic Malignancies" by Clyde L. Randall, M.D., University of Buffalo School of Medicine, Buffalo, New York.

Reservations for the buffet supper are required in advance and should be sent to Dr. Arthur F. Holding, 142 Washington Avenue, Albany 6, New York.

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., B.S., M.A., 103 Rutledge Ave. Charleston, S. C.

A ROENTGENOGRAPHIC SPINAL FIXATION AND STABILIZATION DEVICE

By LIEUTENANT COLONEL WEAVER A. RUSH
Medical Corps, Army of the United States

IN THE Roentgen Department of the Station Hospital, Fort Leonard Wood, Missouri, 5,382 individuals have required roentgen examinations of a part or all of their vertebrae during the period from January 1, 1943, to June 1, 1944. Routine and special studies all required accurate positioning for correct roentgenographic exposures. One position seldom sufficed. Multiple positions were the rule. Conservatively estimated, 3.5 positions per person were required, a total of 18,837 for the group of 5,382. January 1, 1943, to June 1, 1944, provided 466 regular working days in this department. Within the group, however, is an undetermined number of emergency exposures made on Sunday. Roughly estimated, 40 positions daily were required.

Only one capable, well trained, experienced technician had been assigned to the Roentgen Department during this period. All others were totally untrained or had very little training. Many soldiers have received their only training in roentgen-ray exposure technique during their assignment here. Most of these have gone to carry on this work elsewhere and were replaced by men equally untrained.

Instructing men with no, or very little, knowledge of anatomy, roentgen-ray anatomy in particular, was a difficult problem. Their training included instruction in proper positioning. Stabilization and fixation so important in the production of adequate reontgenograms had to be simplified in order to prevent loss of time and materials.

First, we solved this problem so far as stabilization and positioning of the skull was concerned. A simple, efficient, fixation device overcame these difficulties, and we next undertook to provide means for simplifying positioning and stabilization of the spine and pelvis. It was necessary that any method adopted be one that would result in identical positioning regardless of changing technician personnel. We feel that we have accomplished this and in addition there has been an increase in diagnostic quality of the roentgenograms produced.

The positioning device described and illustrated requires that roentgenograms be made with the patient standing. Some objection will be raised to this by radiologists who have not enjoyed the advantages of roentgenograms so made. Patients too ill to stand, will, of course, have to be positioned lying down but these are in the minority.

The device comprises a platform of adequate size mounted on casters. This platform may be fixed in a chosen location by a rubber shod foot, screw controlled, at the extreme frontal limits of the platform. This foot not only secures the device in location but prevents forward tipping when the patient mounts it.

Immediately above this platform a second platform is provided, also mounted on casters or suitable rollers. This platform may be moved forward or backward upon the lower platform by a suitable ratchet device. The necessity for this movement will be developed as description proceeds.

Above this second platform another rotatable disk platform is again mounted on casters or roller bearings. It rotates on a vertical central pivot.

A tubular shaft is affixed to the periphery of the disk and adequately braced. A sliding shaft, nonrotatable, is sheathed within the tubular shaft. It is adjustable for height and provided with set screw fixation. To the top of this shaft is welded a flat metal strip of adequate width and length accurately adjusted to coincide with a plane parallel to the surface of the rotatable disk and directly above a line drawn through a diameter of the disk that would bisect the base of the shaft.

To this flat bar is fitted a sliding saddle, preferably of wooden construction, shaped to meet the anatomical contours of the fronts of the thighs and perineal crotch. This saddle is adjustable both forward and backward. It will be noted (see Figures 1, 2, 3 and 4) that degrees of rotation are indicated by suitable symbols on the surface of the platform that supports the rotatable disk and that an indicator points, finger-like, from the exact center of the base of the shaft. The purpose of this protractor scale and indicator is obvious.

Solidly affixed transversely to the frontal extremity of the flattened bar at the top of the adjustable vertical shaft is a cylindrical hub housing an axle. At its extremities the axle is perforated to receive sliding rods; also thumb screws are properly positioned to lock these rods. This accessory provides an adjustable head and upper spine fixation attachment. The attachment has a cross bar connecting the upper limits of the rods. Stabilization is accomplished by extending the rods to a suitable height and angle so that the patient may bite firmly on the rod which is covered by 4 inches of split rubber tube. A number of these rubber tube cushions are always available, cleaned and sterilized.

The patient is instructed to remove all clothing, including shoes, step upon the disk, mount the saddle and draw it up into his crotch firmly. It is important that he do this himself. Having accomplished this, a web belt is passed around the thighs, snug-

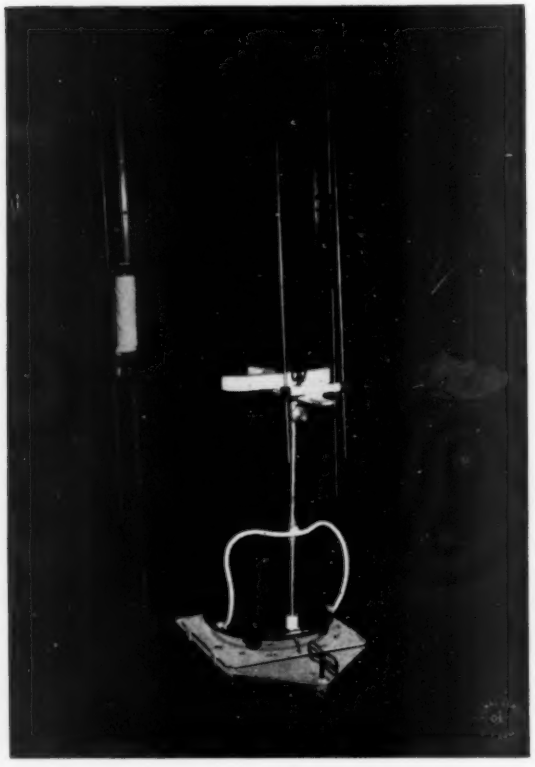

Fig. 1. Frontal view of device.

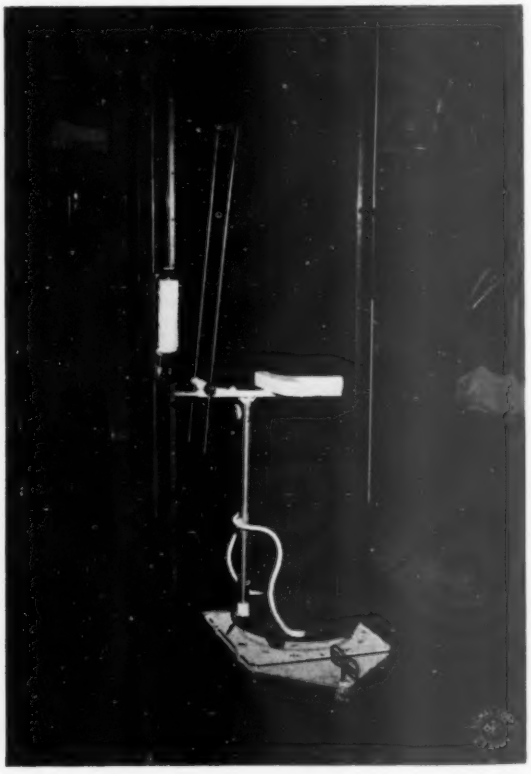

Fig. 2. Lateral view of device.

Fig. 3. Frontal view with patient in position.

Fig. 4. Lateral view with patient in position.

ly drawn and buckled in front of the flat frontal surface of the saddle.

The patient is positioned before a vertical Potter-Bucky grid, the indicator pointing to 0 degrees on the scale. The second or ratchet adjustable platform is moved backward or forward as seems desirable. The saddle is adjusted so that the buttocks are in contact with the surface of the Potter-Bucky grid. The roentgen tube is accurately centered for an anteroposterior exposure. Lateral positions are provided by the simple procedure of rotating the disc 90 degrees. Angle roentgenograms are made at any desired degree selectively and these angles can be accurately reproduced at will at later examinations by referring to the recorded angle and re-establishing this.

The entire spine may be examined at nearly all angles without requiring maneuvers more complicated than the simple act of rotating the disk. Anteroposterior roentgenograms of the atlas and axis through the open mouth are not made by using this device.

The device described has the following advantages:

1. It is of simple construction. No expensive materials are required.

2. Technicians quickly master the simple instructions required to familiarize them with its use.

3. Fixation and stabilization are assured. A multiplicity of positions may be obtained by very simple maneuvers.

4. Very accurate posteroanterior, anteroposterior, lateral and angle positions are assured, all of which can be faithfully reproduced at will.

5. Economic advantages are obvious.

6. Its use provides an accurate means of measuring leg length, recording variations as small as 2 mm. The importance of inequalities in the length of legs is becoming increasingly evident in analyzing architectural instability as a determining factor in low back symptoms.

7. Roentgenographic reproduction of roentgenoscopically predetermined chest positions is accurately accomplished.

AN ADJUSTABLE AND UNIVERSALLY ADAPTABLE PLANIGRAPH

By MAJOR ELMER H. BROCK
Medical Corps, Army of the United States

THERE have been many adaptations of the principles of body section roentgenography by means of a simple and inexpensive apparatus. These have proved of value in certain instances where additional information is needed. This present report is not intended to review the various methods of making an inexpensive apparatus but to describe a particular type.

Most of the homemade designs are constructed for use with a particular type of equipment and are not easily adaptable to other machines. Another limitation to their use is that they are not easily transported and require packing to be shipped.

The present apparatus was designed with the object of making it as flexible as possible for use on various makes of equipment. It was necessary that it be so constructed so that it could be easily taken apart and carried as part of one's personal equipment. The parts when separate can be tied in a bundle small enough to fit in a small locker and be carried as baggage. During the present emergency many radiologists in the Armed Services would like to

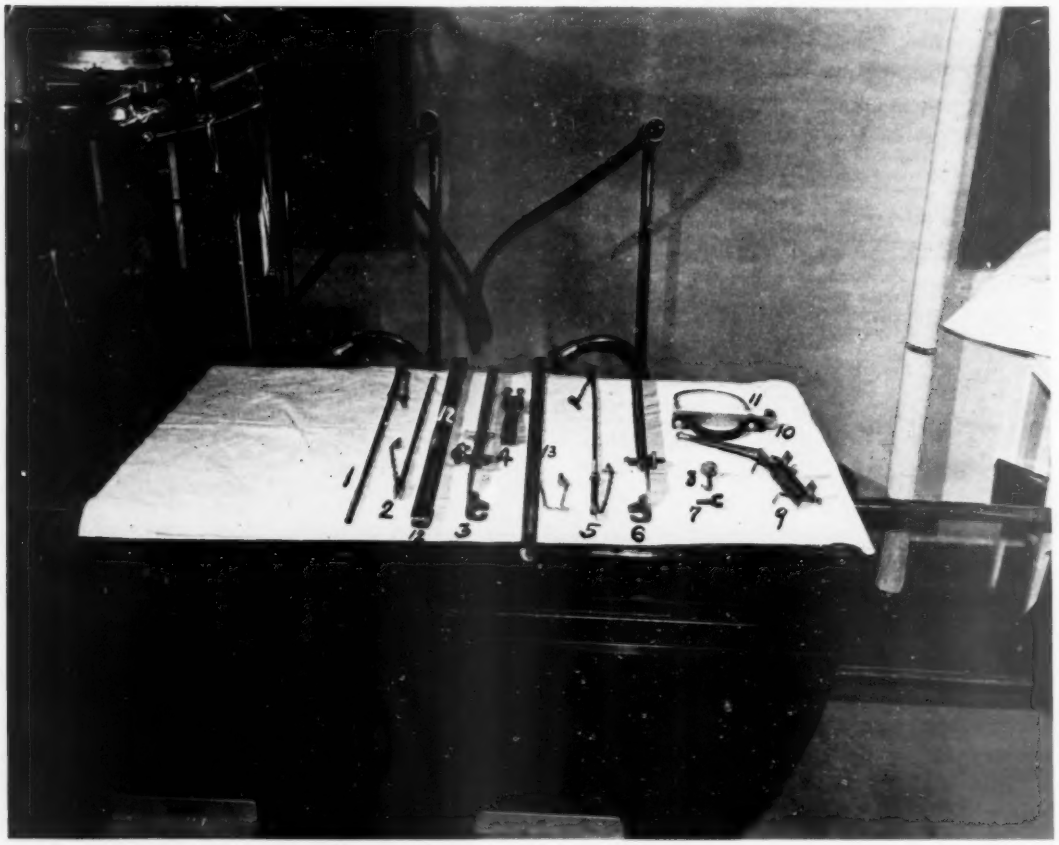

Fig. 1. This photograph shows the various parts separately. Each part is numbered so that it corresponds to the numbering in Figure 2. Description of the parts is given in the text.

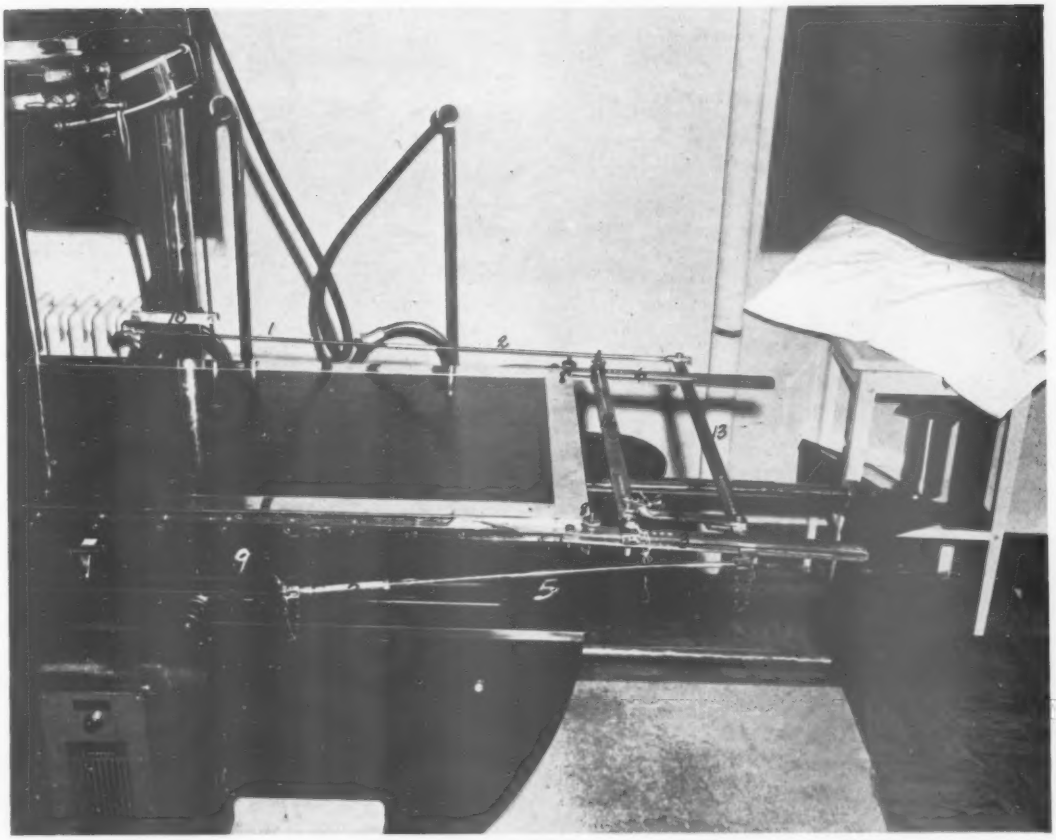

Fig. 2. This photograph shows the parts completely assembled in position for use.

have the additional information of body section roentgenography but do not feel that they can construct a new planigraph on each change of station or for each new installation of equipment.

This apparatus has accompanied the author on all of his changes of station with no more difficulty in transportation than is found with moving textbooks. It has been used on the following makes of equipment to date: Picker Century single tube, Westinghouse Fluoradex, Keleket, and Picker Combination. With this experience there is sufficient evidence to indicate that it could probably be used with any standard equipment. In many instances it has proved of value as an additional diagnostic aid.

The accompanying photographs will show how the apparatus can be assembled. Figure 1 shows the separate parts. These parts are numbered consecutively with corresponding numbers on the assembly shown in Figure 2. *1* and *2* comprise the long rod extending from the lever arm, *13*, to the tube stand and can be lengthened and shortened at either end, and in the center. *3* and *6* are fitted with a hook at each end to fit the side rail. These are the same as the hooks of the foot plate used for tilting the patient from upright to recumbent position. The bar, *12*, has holes drilled to allow the fulcrum, *4*, to be attached. This should be made so that it will be rigid when fitted in place. This has been accomplished here by inserting a small set screw at the base to take up any slack that is present. The bar, *13*, forming the lever arm has holes at each end for the attachment of *2* and *5*, and holes drilled 1 cm. apart for the adjustment of the lever arm to vary the

height of the plane above the table top. *5* is the rod attached to the Bucky tray by means of a removable clamp, *9*. *8* is a screw with a small hook on the end to hold the side pieces *3* and *6* snug to the side rail of the table. *10* and *11* are "U" bolts which hold a small projecting arm on the tube stand for attachment of *1*.

It is easy to see that this entire assembly merely constitutes a framework for the free operation of a lever arm to move the tube and plate synchronously in a reciprocal motion. The measurements can be easily obtained directly by measuring the distances on any standard table. The important point to remember is that the distances should be measured with the tube centered over the Potter-Bucky grid. Inasmuch as different tables vary slightly in size, those parts which form the lever arms should be adjustable, and all other parts that interconnect should be adjustable. The main parts used here were fabricated from cold rolled steel or pieces of metal from salvaged equipment.

The author wishes to express his appreciation for the invaluable help given in designing this apparatus by Dr. S. A. Morton and Mr. Dudley Slauson of the Department of Radiology, Columbia Hospital, Milwaukee. Credit for the mechanical work and fabrication of the various parts should go to members of the Ordnance Corps of the United States Army.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

Schwartz, Charles Wadsworth. Pitfalls to be avoided in the roentgen diagnosis of intracranial disease. *Radiology*, Jan., 1944, *42*, 34–41.

There are many conditions that may lead to mistaken diagnosis in the roentgen interpretation of findings in the skull. In the first place no conclusions must be drawn from an inadequate set of roentgenograms or those made by poor technique. Nor must they be drawn from a study of only one part of the skull. Every part must be carefully studied and the search must not be given up after finding one anomaly for there may be several, all or none of which may be of clinical significance.

An arbitrary normal zone has been decided upon for the location of the pineal body but this normal zone is too large for absolute accuracy. The body may lie within the normal zone, even if there are pathological changes and it may lie slightly outside the normal zone without such changes. A lateral pineal shift can be detected easily in good roentgenograms taken either anteroposteriorly or posteroanteriorly.

Anomalous appearance of the veins may be misinterpreted. Not infrequently the diploic venous channels are larger than normal. If there is an area of hypervascularity that is of real pathological significance, there is usually some bone reaction near it, such as spiculation or atrophy. To be considered really hypervascular an area must be hypervascular in comparison with other areas of the same head, not in comparison with any arbitrary standard.

The diploe may be coarse or fine, plentiful or scanty, regularly or irregularly distributed. These possible variations must be considered in interpreting the roentgenogram. A fine diploe may suggest that the calvarium is granular and arouse the suspicion of hyperparathyroidism or other disturbance of calcium metabolism. The coarse type of diploe may suggest spiculation, porosity or fibrotic changes in the bone. Careful stereoscopic study will generally reveal the mistake.

Not infrequently in lateral views of the skull there are fine lines at various angles to the plane of the vault that suggest bony spiculations or striations of the type seen in the erythroblastic anemias. But they are caused by a particularly well serrated sagittal suture and the appearance of the bone is healthy. Persistent or double suture lines may suggest fracture and the differentiation must be made carefully. The malar bone may originate from two or three centers of ossification and the appearance may suggest fracture. The congenital lack of a superior orbital plate, as well as other anatomical anomalies, may lead to confusion. Convolutional impressions are often misinterpreted as being evidence of increased intracranial pressure when they are not. An increase in depth and number of these markings may occur in malacic disturbances due to defective calcium metabolism. A demineralized sella turcica may also be misinterpreted as a sign of pressure atrophy when it may be due to a systemic abnormality of calcium metabolism. Atrophy first becomes apparent in the posterior clinoid processes and dorsum sellae and if the cortex of these parts is less dense than that of the adjacent bone it indicates atrophy.

Symmetry of the skull is never perfect, so care must be exercised in interpreting asymmetry as abnormal. About 10 or 15 per cent of skulls show congenital asymmetry of the petrous pyramids. Asymmetry may be of considerable clinical significance if it results from agenesis or hypoplasia of one cerebral hemisphere. This is sometimes seen in patients with convulsive disorders. Asymmetry of the frontal cells is not of much significance but the size and shape of the frontal cells may give evidence as to the endocrine condition of the patient.—*Audrey G. Morgan.*

Camp, John D., and Nash, Leo A. Developmental thinness of the parietal bones. *Radiology*, Jan., 1944, *42*, 42–47.

Developmental thinness of the parietal bones is of two types, the flat type and the grooved type as seen in the posteroanterior projection. It is usually bilateral and symmetrical and there is a smooth, progressive thinness from the periphery of the affected area to its center. The diploe is lacking in the affected area and the external table is thinned and depressed. Some authorities have claimed that the internal table is also affected but this was not true in the 119 cases examined by the authors. The condition can be shown by the usual lateral and posteroanterior roentgenograms of the head, though it can be shown better by tangential views over the affected part of the skull. It is better to examine the roentgenogram by means of a small bright lamp than by the roentgenographic viewing box. Roentgenograms of the two types of thinness are shown and diagrammatic sketches showing the areas involved.

This has often been described as an old woman's disease but of the authors' cases 80 were in males and 39 in females. The average age for the whole group was fifty-four years and for the females fifty-six years. Ten of the patients were thirty years of age or less. One patient was a four year old child.

The condition is not of particularly great clinical importance except that it may be mistaken in the roentgenogram for osteolytic metastatic carcinoma, myeloma, xanthomatosis, osteoporosis circumscripta and a number of other pathological conditions of the skull. The authors believe the condition is not progressive as it was as intense in their younger as in their older patients, and there was never thinness of such a degree as to be classified as a parietal foramen. They believe there is no relationship between these two conditions.—*Audrey G. Morgan.*

Brunner, Hans. Chronic osteomyelitis of the skull. *Ann. Otol., Rhin. & Laryng.*, Dec., 1943, *52*, 850–894.

Chronic osteomyelitis differs from the acute form in almost every respect. Therefore, the differential diagnosis between the two types, as a rule, does not meet with great difficulty. However, among the cases of chronic osteomyelitis there seem to be two different types: one type which presents the typical features of an acute osteomyelitis at the onset of the disease, and another type which does not. In order to differentiate these, the latter type is called "chronic osteomyelitis of primary type" and the former "chronic osteomyelitis of secondary type."

Chronic Osteomyelitis of Primary Type.

Etiology. Infection of the paranasal sinuses is less important than in acute osteomyelitis. In the case reports presented in this article, 1 was due to erysipelas of the skull, 1 to scarlet fever, 1 to a head injury, 1 to adenocarcinoma of the paranasal sinuses with subsequent obstruction to both nasofrontal ducts, 1 to a skull injury, and 2 to pansinusitis.

Clinical Course. Chronic osteomyelitis of the primary type is chiefly characterized by its insidious onset and by its slight tendency to spread.

Pathology and Roentgenology. The normal frontal sinus of adults is bounded by a broad line which has double contours and presents the marginal compacta. In roentgenologic terminology, the margins of the frontal sinus are distinct. The margins of the small frontal sinuses in children and in young adults are partially indistinct under normal circumstances indicating the absence of a marginal compacta. Therefore, in instances of a small frontal or sphenoid sinus a partial indistinctness of the boundaries does not necessarily indicate a pathological condition of the bone even if there is a slight haziness of the sinus, the latter finding being due to the small diameter of the sinus.

In chronic sinusitis a fuzzy appearance of the boundaries and a sclerotic area, particularly at the lateral and superior angles of the frontal sinus, can frequently be observed. This finding indicates a marginal osteitis provided the sinus

has reached its complete development and is definitely cloudy.

In actual chronic osteomyelitis all these changes reach a climax. The outlines of the sinus may disappear entirely and due to the thickening of the anterior wall, the area of the frontal sinus is replaced by a sclerotic area. Frequently the report of the roentgenologist indicates a failure of development or an absence of one frontal sinus in these instances.

Treatment. The osteomyelitis in these cases may continue for years without leading to an intracranial complication. Thus, the operative procedure which may be required is not an emergency performance. The immediate purpose of surgery is to relieve the patient of pain and toxemia.

Chronic Osteomyelitis of Secondary Type.

Etiology. Acute infection of the paranasal sinuses (organism either hemolytic streptococcus or staphylococcus in the cases reported).

Clinical Course. Acute onset, a slow but definite tendency to spread within the bone, and a marked tendency to spread within the blood (viz., chronic septicemia).

Pathology and Roentgenology. The study of the roentgenograms seems to indicate that the pathology is very similar to that of chronic osteomyelitis of the primary type. The infection in both instances produces osteoclasis and osteogenesis, the latter being predominant. Due to these changes, thickening and sclerosis is caused, on the one hand; sequestra, on the other. However, there are some points of difference between chronic osteomyelitis of primary and secondary type. While in the former the sclerosis is to be found in the boundaries of the frontal sinus and spreads extremely slowly into the surrounding parts, in the latter the frontal sinus may regain its normal appearance while the sclerosis and sequestra are to be found in the distant parts of the skull, as in the vault or in the malar bone or in the wings of the sphenoid. Therefore, in instances in which a roentgenogram is taken several years after the onset, the boundaries of the frontal sinus may appear distinct, although the disease undoubtedly originated in the frontal sinus.

Treatment. Treatment in these cases is extremely unsatisfactory. There are a chronic septicemia, a widespread osteomyelitis and, as a rule, metastases which may eventually also serve as the origin of septicemia. It is obvious that under these circumstances surgery cannot accomplish very much.—*Mary Frances Vastine.*

Epstein, Bernard S., and Kulick, Max. Technic for optic foramen roentgenography. *Radiology*, Feb., 1944, *42*, 186–187.

The authors describe a method of roentgenography of the optic foramen which obviates the necessity for mechanical devices and gives fairly uniform results. The cassette is placed on a 2 inch block and a cone with a 3 inch aperture focused so that the central ray passes through the center of the film. The tube and cone are elevated and the head placed so that the malar eminence, the tip of the nose and the superior orbital ridge form the apices of a roughly equilateral triangle in the circular roentgen field. The orbital ridge is then raised 1 inch from the cassette. It may be kept in this position by a wedge of felt. In this way the central ray is directed perpendicularly downward. On the roentgenograms the optic foramina appear as circular structures in the lower part of the orbits. The same results have been obtained with an angle board using a 15° angle. The inclined plane is grooved so that a cassette can be inserted. The center of the roentgen field is marked by a cross. The tube is centered over the cross and the head is placed so that the superior orbital ridge, the tip of the nose and the malar prominence are in contact with the inclined plane, the orbit being in the middle. A lead mask may be used to pre-expose the films so that the finished roentgenogram shows a black periphery. The angle board can be made in any carpenter shop.

Photographs of the patient in position and roentgenograms of the optic foramina are shown. The physical factors are 55 kv., 50 ma-sec., cone 7 inches long with 3 inch opening.—*Audrey G. Morgan.*

Berkove, Alfred B. Hypertelorism. *Arch. Otolaryng.*, Dec., 1943, *38*, 587–589.

This is a case report of hypertelorism seen in the Eye, Ear, Nose and Throat Clinic of the Station Hospital, Camp Beale, California. Hypertelorism is a congenital abnormality, the diagnosis of which is made evident by the facial appearance. The condition may be defined as a craniofacial dysostosis resulting from the overgrowth and early ossification of the wings of the sphenoid bone.

The roentgenologic findings seen in this ab-

normality consist of: (1) overgrowth of the lesser wings of the sphenoid; (2) separation of the orbits (large interpupillary distance); (3) excessive width at the base of the nose (with distortion of the tip. In most cases there is a divergent squint).—*Mary Frances Vastine.*

McNally, W. J., Stuart, E. A., and Childe, A. E. Mucocele of the frontal sinus. *Arch. Otolaryng.*, Dec., 1943, *38*, 574–586.

Recently at the Royal Victoria Hospital a mucocele of the frontal sinus was operated on and the sinus was found to be empty. This was the second such case in the past two years. There is much difference of opinion as to just what constitutes a mucocele. One of the best definitions is that of Dabney: "the accumulation and retention of mucous secretion within an accessory sinus, generally associated with a distention of one or more of its walls." Eleven cases of mucocele of the frontal sinus have been diagnosed in this hospital over the past twenty years. Five cases are reported by the authors.

Etiology of Mucocele. Unknown. There are probably a variety of causes.

Symptomatology. The symptoms of mucocele are few.

1. Slowly developing periorbital swelling which is usually painless.
2. The floor of the sinus is usually distorted. The posterior or anterior wall may also be affected.
3. Exophthalmos from deformity of floor of sinus.
4. Fluid contents which may be sticky and mucous, dark and bloodstained or mustard-like in substance.

Differential Diagnosis.

1. Cystic dilatation of the lacrimal sac in which the swelling first appears at the inner angle of the eye. This is below the level at which a mucocele breaks through (either the anterior ethmoid cells or the inner end of the floor of the frontal sinus).
2. Tumor and abscess within the orbit in which case exopthalmos is present without necessarily deforming the floor of the frontal sinus.
3. Tumor of the frontal bone can be differentiated roentgenographically.
4. Epidermoid cyst (cholesteatoma) is usually present from birth and increases in size gradually. It is more likely to be found in the region of the outer canthus.
5. Meningocele is usually present at birth. It is in the midline and appears above the bridge of the nose. It is cystic and pulsates when the child is at rest. During crying the tumor expands.
6. Meningioma (meningeal fibroblastoma) is unusual in the frontal sinus area. Since it arises within the skull there may be signs of intracranial involvement before there is any external swelling.

Roentgenographic Observations.

1. Dilatation of the whole or some portion of the involved frontal sinus. The opposite frontal sinus may also be involved.
2. The cavity is smooth walled with a slightly whitened margin. It is relatively translucent.
3. The bony septa ordinarily present in the frontal sinus are obliterated.
4. The bony walls may be thinned out and bulged. Defects in the bone may result. The floor is usually primarily involved.
5. The roentgenographic differential diagnosis between epidermoid and mucocele is not easy to make. This is true because the margin of the epidermoid is usually smooth and dense and the tumor is radiotransparent owing to its high cholesterol content.

Treatment. This consists of adequate and permanent drainage which can be obtained only by an external operation.—*Mary Frances Vastine.*

Windeyer, B. W. Malignant tumours of the upper jaw. *Brit. J. Radiol.*, Dec., 1943, *16*, 362–366.

In the Skinner Lecture for 1943 the author discusses a series of 153 consecutive malignant tumors of the upper jaw. By this he means carcinomas and sarcomas originating from the walls or within the cavity of the maxillary antrum; as it is frequently impossible to determine the site of origin of a growth involving both the antrum and the ethmoid region, he has included ethmoid tumors. A consideration of these cases shows the necessity for complete cooperation between surgeon, pathologist, roentgenologist and radiotherapist.

In this series there were 81 males and 72 females, not a great enough difference to be of any significance. No determining cause for the growth was found. There were few cases with a history of sinus infection and repeated operation for the removal of polyps. A number of

cases are illustrated showing the direction in which the tumor grows, depending on its point of origin. The symptoms also vary, depending on the part involved. There is generally pain from involvement of the branches of the fifth nerve. If the spread is in the anterolateral direction the pain is referred to the upper teeth and over the cheek. With spread through the posterolateral wall there may be earache and pain referred to the upper molar teeth on the affected side. This in combination with trismus and the frequency with which a tumor in the temporal region is overlooked may lead to a mistaken diagnosis of dental sepsis. Tumors in the ethmoid region are frequently associated with severe headache and a foul-smelling nasal discharge. When the site of the primary growth is the orbital plate double vision may be the first symptom.

The proportion of sarcomas to carcinomas in this series was lower than in the majority of reports. Metastases were found both in the regional lymphatic glands and in distant organs. A clinical diagnosis of cervical gland metastases was made on admission in 45 of these cases and found in 5 others later, making a total of 32.7 per cent. Probably some of these glands were enlarged as a result of secondary infection. There were generalized metastases in lungs, liver, kidneys and bones in 14 cases, or 9 per cent. Some of the patients had both glandular and distant metastases and the total number of cases with metastases was 59, or 38.6 per cent. —*Audrey G. Morgan.*

Lederman, M. Adenolymphoma of the parotid salivary gland. *Brit. J. Radiol.*, Dec., 1943, *16*, 383–385.

Adenolymphoma of the parotid gland is one of the rarer forms of salivary gland tumor and further information in regard to the effects of surgical and radiation treatment in these tumors is urgently needed. Four cases treated in the Radium Department of the Royal Cancer Hospital are described. The first was a malignant case in a man of sixty-six. Malignant cases are unusual. He was first given treatment with teleradium, 1 gm. unit; surface dose 2,000 r in nine days. There was little or no effect until larger doses (4,000 r or more) were given. In spite of the malignant nature of the case the patient was kept alive for ten years. The other 3 patients with benign adenolymphomas were a woman of fifty-four, a boy of fourteen and a woman of forty-two. Two of these were recurrent after previous operation. Experience in these cases seems to indicate that benign adenolymphomas may be expected to respond satisfactorily to doses of about 5,000 r, using either postoperative implantation over a period of seven days or less, or external irradiation over a period of three to four weeks.

It may be necessary to use radium as the sole method of treatment for an inoperable recurrence, for a benign tumor if operation is contraindicated, for the rare malignant tumor if inoperable. It may be used as a postoperative measure when excision in a given case is known to have been incomplete, for routine use in benign cases if the recurrence rate after excision is shown to be high enough to justify this step. —*Audrey G. Morgan.*

NECK AND CHEST

Fawcitt, Richard. Radiological evidence in haematite iron-ore workers. *Brit. J. Radiol.*, Nov., 1943, *16*, 323–330.

The author discusses the findings in the lungs of hematite iron workers in the Furness and South Cumberland region of the Lake District in England. He formerly examined many of these workmen and labelled them silicotics. He finds now that the condition is a siderosis, that is a fibrosis of the lungs as a result of iron-ore particles or hydroxid of iron in the lungs, apart from an abnormally high silica content with its accompanying glandular changes. This condition was found to be worse in the Cumberland mines than in the Furness mines. This is probably because the Cumberland mines are much drier than the Furness mines and dry drills are used which blow fine dust into the miners' faces which is inhaled. In the Furness mines they use wet drills in which a stream of water runs along the side of the drill and prevents the dust from flying.

Roentgenograms of a number of these cases are given. Hematite is radiopaque and the first stage of siderosis shows increased lung reticulation which progresses to a stage suggestive of small nodes. The author calls the picture snowflake mottling. In damp mines of low silica content there are exaggerated linear markings sometimes associated with snowflake mottling. This indicates the possibility of infection which is always a danger. The next stage shows small patches of coalescence with snowball effect in the upper lobes and emphysema of the bases.

The patches of coalescence become more extensive and compact. At this stage superadded infection is likely and is indicated by spread of the opacity to the outer lung fields. Finally in some cases diffuse areas of consolidation develop and the picture of tuberculosis or malignant disease is seen on roentgen examination. The greatest danger is infection with tuberculosis which affects not only the miners but their families and both morbidity and mortality from this disease are high in these regions. The treatment is symptomatic. The industrialists are trying to do what they can to prevent the development of the condition and valuable research work is being done by their physicians. The men are coming to appreciate the value of the wet drills and it is hoped that the old conditions with dry drills may never be repeated.—*Audrey G. Morgan.*

Camiel, Mortimer R., and Berkan, Henry S. Inhalation pneumonia from nitric fumes. *Radiology*, Feb., 1944, *42*, 175–182.

Acute inhalation pneumonias from the inhalation of noxious fumes are increasing in frequency. Nitric fumes occur commonly in industry but are not toxic unless generated in confined unventilated places. But they may cause serious damage or even death from rapidly fatal edema of the lungs.

The authors describe 2 cases and give illustrative roentgenograms. Both these patients recovered and there was marked improvement in the roentgen findings in a few days. Both the patients were men of forty; the first had been engaged in cleaning metal and had been mixing nitric acid with hydrochloric acid without a mask. The second patient was a welder's assistant who worked in a ship's hold without a mask. The symptoms are headache, dizziness, palpitation and respiratory distress. There is a latent period after exposure of from a few hours to twenty-four hours so the cause of the illness is sometimes not discovered. In both these cases the roentgenograms showed a pseudonodular infiltration that completely filled both lung fields. During the most acute stage the infiltrations varied in size from that of a match head to that of a pea. In many areas they were confluent and formed larger patches but the nodular character was still evident. Clinical improvement occurred at the same time as improvement in the roentgen picture. Follow-up examinations after some months showed complete absence of residual changes in the lungs.

Such cases show the necessity for prophylactic industrial measures.—*Audrey G. Morgan.*

Schmidt, Herbert W. Benign nontuberculous bronchial stenosis. *Arch. Otolaryng.*, Jan., 1944, *39*, 43–52.

In the past, syphilitic bronchial stricture has been described. At present, much is being written about tuberculous bronchial stricture. Not much attention has been called to stricture produced by nonsyphilitic and nontuberculous inflammation of the bronchi. This type of stricture may develop secondary to a chronic bronchial infection such as that seen in cases of chronic asthmatic bronchitis. Secondary and tertiary bronchi are principally involved. Primary bronchi are occasionally involved. One must assume that the inflammatory reaction throughout the bronchial wall must have been severe enough to cause fibrosis with subsequent stricture. Stagnation of bronchial secretions probably also plays an important part in the genesis of this type of lesion.

This paper is based on a study of 25 cases of benign nontuberculous bronchial stenosis in which bronchoscopy was performed. Four of these cases are reported.

Symptoms. The syndrome of benign nontuberculous bronchial stenosis is a rather definite one. There is usually a history of antecedent pneumonia, severe tracheobronchitis or repeated seizures of asthmatic bronchitis. After variable periods, recurrent bouts of chills, fever and general malaise develop. The period of fever is usually preceded by an irritating, nonproductive cough. The temperature may reach 102 to 103° F., and the elevation may persist for two to seven days, at the end of which time variable amounts of purulent secretion are coughed up. In an attack there is stagnation of infected material distal to the stricture of the bronchus. A local pneumonic process develops.

Physical Findings. Benign nontuberculous bronchial stenosis is more likely to occur in the lower lobe than in the upper lobe or in the middle lobe of the right lung. Physical findings may be absent, since the stenosis usually involves the third division of a bronchus. If physical findings are present, they usually are those of obstructive atelectasis, namely, dullness on percussion and decrease in breath sounds over

that portion of the lung supplied by the involved bronchus.

Roentgenologic Findings. In obstructive atelectasis the physical findings may be of more value than the roentgenologic findings. Roentgen examination is important in determining the presence of atelectasis, but the roentgen findings alone will not always enable one to determine whether or not a bronchus leading to the affected region is open or closed.

The roentgen findings in obstructive atelectasis may be listed as follows: (1) The pulmonary field is reduced on the affected side. (2) The heart and mediastinum are displaced toward the affected side. (3) There may be narrowing of the intercostal spaces with increased downward angulation of the ribs. (4) There are elevation and decreased motion of the diaphragm on the involved side. (5) The atelectatic region itself will show increased density. (6) The trachea is displaced toward the side of the lesion. (7) On inspiration, the heart is drawn toward the affected side, and on expiration the mediastinum moves away from this side. (8) Bronchography may help to determine whether or not an obstruction exists and to localize the site of obstruction.

Bronchoscopic Findings. Bronchoscopy is the only clinical method of determining whether or not benign bronchial stenosis exists. The involved bronchus is seen to be reduced in size or it may be completely closed. It has a rigid appearance; that is, it does not increase in size during inspiration and decrease in size during expiration. Almost always there is a trickle of purulent secretion coming from its orifice. When touched, the bronchus bleeds more readily than the normal.—*Mary Frances Vastine.*

Cutler, J. W. The harmful influence of pregnancy on advanced tuberculosis as modified by collapse therapy. *Am. J. Obst. & Gynec.*, Jan., 1944, *47*, 1–19.

This presentation concerns itself with the effects of pregnancy upon advanced tuberculosis in a series of 26 white women who were treated with collapse therapy. These 26 women gave birth to 40 children of whom 36 are alive and well. This study points to certain facts:

1. Pregnancy affects some patients with tuberculosis unfavorably. Exacerbation may occur either in the early months of pregnancy or within the first few months following delivery.

2. Collapse therapy has definitely minimized the risk and has brought a better outlook to the expectant tuberculous mother.

3. If the disease, though advanced, is limited to one lung, as indicated by roentgen examination, and the diseased area is anatomically well collapsed with all cavities closed, the sputum free of tubercle bacilli, and the collapse maintained throughout pregnancy, there is little or no risk of reactivating the tuberculosis and such women may safely undertake one or more pregnancies. The same is true if there is advanced tuberculosis in both lungs, but with the disease in each lung controlled with adequate collapse therapy. Indeed, one may regard the interval of effective collapse therapy as the safest period for a tuberculous woman to marry, have children, and rear a family.

4. If there is disease in both lungs and only one lung is treated with collapse therapy, the disease in the uncollapsed lung, although quiescent before pregnancy, may become active in approximately 30 per cent of the cases. This is true even if the disease in the contralateral lung is minimal in extent, well stabilized for months or years, and the sputum negative for tubercle bacilli at the time of pregnancy.

5. The possibility of reactivating quiescent tuberculosis in an uncollapsed lung, however, is not in itself a contraindication to pregnancy. Permission may be given as long as the patient is kept under observation and is willing to accept collapse therapy when it first becomes indicated.

6. Pneumothorax therapy may be considered as an alternative to therapeutic abortion in the presence of active tuberculosis first recognized during the early months of pregnancy. When the collapse is good and promptly controls the tuberculosis, the woman may proceed safely to term.

7. Only collapse therapy which produces adequate localized collapse of the diseased portion of the lung, such as pneumothorax, maintenance oleothorax, or thoracoplasty, will prevent reactivation of the disease. Indirect collapse, such as phrenic nerve interruption, is not enough.

8. Inadequate collapse therapy may be considered the same as if no collapse therapy is employed so far as the effect of pregnancy on the tuberculosis is concerned.—*Mary Frances Vastine.*

Vineberg, Arthur M., and Kunstler, Walter E. The determination and treatment of pressure cavities in pulmonary tuberculosis. *Surg., Gynec. & Obst.*, March, 1944, *78*, 245–274.

The authors have worked out a new technique of transthoracic intracavitary drainage which requires the use of special instruments in addition to those devised for cavity needling. The instruments used were designed by the writers. Too often large cavities are closed by multiple stage thoracoplasties, the disease is arrested and the patient becomes a respiratory cripple. It is apparent that a more efficient and less destructive method of collapsing cavities is desirable. Such a method seems to be on hand in the form of transthoracic cavity drainage.

This study of pressure cavities in pulmonary tuberculosis is a very complete one and for it, the authors were awarded the Casgrain-Charbonneau Prize 1942 by the Faculty of Medicine, McGill University. The following points are included in the summary:

1. A large percentage of pulmonary tuberculous cavities are "tension cavities" and rarely close with thoracoplasty.

2. Some residual cavities are "tension cavities" which are unaffected by thoracoplasty.

3. The detection of "tension cavities" can be made only by needling of the cavity and recording of the intracavitary pressures.

4. Transthoracic intracavitary suction drainage is recommended only for use in "tension cavities."

5. In 150 instances, cavities were needled and 27 cavities were drained without a single complication of hemorrhage, pleural empyema, spontaneous pneumothorax, or air embolism.

6. Intracavitary suction drainage will reduce large "tension cavities" to the size of a catheter; to obtain permanent closure a partial thoracoplasty is essential.

7. In giant positive pressure cavities, anterior stage thoracoplasty precedes suction drainage and the latter is followed by posterior stage thoracoplasty.

8. Negative pressure giant cavities close readily with thoracoplasty.

9. By the use of a combination of transthoracic intracavitary suction drainage and thoracoplasty in the treatment of "tension cavities" the ideal of collapse therapy is attained, namely, a maximum collapse of diseased areas with a minimum of damage to normal lung parenchyma.—*Mary Frances Vastine.*

Johnstone, A. S. Peptic ulceration of the oesophagus with partial thoracic stomach. *Brit. J. Radiol.*, Dec., 1943, *16*, 357–361.

Peptic ulcer of the esophagus was first recorded by Quincke in 1879 but the combination of peptic ulcer and short esophagus seems to have been first described by Briggs, Dick and Hurst in 1939. There are two schools of thought in regard to the cause of this combination. One holds that it is always the result of congenital shortening of the esophagus so that a part of the stomach is pulled up into the thorax. But Chevalier Jackson reports 21 cases in which there was no coexisting abnormality of the esophagus.

The author has records of 21 cases. He discusses the roentgen findings, which are illustrated by roeentgenograms. On the basis of his findings he concludes that peptic ulceration of the esophagus and partial thoracic stomach are inseparable. They are seen chiefly in elderly people, especially of the sthenic build, in whom the development of hiatus hernia is almost a normal process. The frequent regurgitation of acid, in association with other factors, may cause peptic ulceration which becomes chronic and causes sufficient cicatrization to shorten the esophagus and produce partial thoracic stomach. There is no doubt, however, that in some cases the partial thoracic stomach is congenital. The author reports one proved case in a young man of twenty-three in whom no hiatus hernia was found.—*Audrey G. Morgan.*

ABDOMEN

Levine, Samuel, and Solis-Cohen, Leon. Survey film diagnosis of acute surgical abdomen. *Surg., Gynec. & Obst.*, Jan., 1944, *78*, 76–82.

A minimum of three roentgenograms should be taken: a high and a low supine view and an upright view. In cases in which the patient's condition permits, roentgenograms in the prone and lateral decubitus positions are advantageous. A few of the many interesting points brought out in the article may be outlined as follows:

1. Ruptured peptic ulcers are more often the cause of free intraperitoneal air than ruptured

appendices. When the patient is roentgenographed shortly after the onset of the perforation, no free air may be seen.

2. When air collects beneath the left diaphragm it may be confused with the magenblase; to obviate this, a right decubitus view should be taken.

3. After laparotomy free intraperitoneal air will persist for about ten days.

4. In hepatocolic interposition, care must be exercised in interpreting the upright view.

5. In cases of intestinal obstruction, the more proximal the obstruction, the greater the degree of intestinal dilatation. If there is marked small intestinal dilatation the involvement is most likely jejunal since more secretory activity occurs in the jejunum than the ileum. It is usually abnormal to find gas within the small bowel.

6. Ingested air may traverse the small bowel in six to fifteen minutes.

Morphine may cause gas to appear in both the small and large intestine. Morphine affects, chiefly, the duodenum. The duodenum is first constricted and then dilated by this drug.

8. Ordinarily the ileocecal valve blocks the egress of gas from the small into the large bowel. In sigmoidal obstruction of long standing there may be regurgitation of air into the cecum with marked distention or even rupture of the cecum. Therefore, tremendous dilatation of the cecum on survey roentgenograms should arouse the suspicion of a low colonic obstruction.

9. In a lacerated spleen, the blood gravitates along the gastrolienal ligament so that the greater curvature of the stomach assumes a serrated appearance because of the juxtaposition of the adjacent hematoma. The stomach is displaced to the left and the colon downward.

10. Mesenteric thrombosis yields a picture similar to that of ileus. In this type of case, the small intestinal loops are only slightly dilated. Mesenteric abscess produces a homogeneous radiopaque shadow surrounded by dilated small intestinal loops.

11. Volvulus is invariably associated with considerable elongation and reduplication of the sigmoid. In this condition, markedly dilated loops of large intestine usually are seen near the hepatic flexure.

12. In tuberculous adenitis, one may encounter complete duodenal obstruction resulting in marked gastrectasis.

13. A ruptured abdominal aneurysm may simulate an acute surgical abdomen. The roentgenogram shows a diffuse homogeneous density to the left of the lumbar spine obliterating the left ileopsoas line.

14. In atresia of the sphincter and in the newborn, it may be advantageous to examine the patient in the Trendelenburg position; distention of the large bowel including the rectal ampulla, the column of air stopping short of the anus, may be noted.—*Mary Frances Vastine.*

Brindley, G. V. Acute obstruction of the colon. Editorial. *Surg., Gynec. & Obst.*, May, 1944, *78*, 556–558.

It is conservatively estimated that 20 per cent or more of the patients with acute obstruction of the colon lose their lives.

Etiology of Large Bowel Obstruction. The etiology is quite varied. However, a fact worthy of emphasis is that carcinoma produces obstruction in this part of the intestinal tract in 80 per cent or more of the cases. About 10 per cent of all malignant lesions of the colon produce obstruction and, of these obstructions, 7 out of 8 are in the left half. Obstructions of the colon due to malignant disease occur mainly in elderly persons for 70 per cent of the patients with cancer of the colon are over fifty years of age. The next most frequent causes of obstruction in this region are volvulus, diverticulitis, chronic inflammation, benign strictures, and intussusception.

Clinical Features of Obstruction. The symptoms develop more slowly in occlusions of the large intestine than in those which occur in the small bowel. However, when the obstruction has persisted long enough for the blood supply of the intestine to become impaired, the patient will frequently pass rapidly into a serious state and in a question of hours his condition may become hopeless. The marked biochemical changes which develop rapidly in obstruction of the small intestine are not seen in occlusions of the colon.

Treatment.

1. Obstruction due to bands usually demands only the severance of the bands.

2. Obstruction due to benign stricture usually requires an entero-anastomosis around the obstructing segment.

3. Torsion of the intestine is treated by a reduction or resection of the volvulus.

4. Obstructions occasionally produced by en-

dometrial adenomas can be controlled by surgical attention to the female generative organs or by means of radiation therapy.

5. Diverticulitis seldom produces complete obstruction and an occlusion due to it can usually be decompressed by medical management.

6. To cure an occlusion of the colon due to carcinoma, it is necessary to resect the lesion widely. Experience has shown that a primary resection of the colon should never be done in the presence of an acute obstruction which is due to a neoplasm for it is unnecessary and the mortality is prohibitive. A cecostomy or colostomy in the transverse colon is indicated to relieve the distention. Usually the obstructed colon is decompressed adequately by this means for a safe resection later.—*Mary Frances Vastine.*

Birnkrant, Milton. Traumatic serous cyst of the lesser omentum. *Radiology*, Jan., 1944, *42*, 74–76.

Serous omental cysts are rarely of traumatic origin. In fact only 1 case has been described before this one. In this case the patient was a carpenter twenty-three years of age. His assistant fell from a scaffold and in so doing struck him in the abdomen with his elbow. He felt severe epigastric pain followed by colic and persistent vomiting. The pain abated and his condition remained stationary until the eighteenth day when he had a recurrence of the abdominal pain and vomiting. A roentgenogram of the abdomen five days after the injury showed the colon distended with gas with the middle part of the transverse colon at the third lumbar vertebra. A barium enema seventeen days later showed the transverse colon at the level of the lumbosacral articulation. It was concave upward and the haustral markings were lost. There was a diffuse homogeneous opacity in the upper abdomen. The findings were thought to indicate a mass depressing the transverse colon.

Operation showed the upper abdomen filled by a large round encapsulated mass which depressed the stomach and displaced it forward. The gastrocolic membrane was thickened and infarcted. It formed the anterior wall of the tumor which was found to be a cyst of the lesser omental sac. Five thousand cubic centimeters of straw-colored fluid were withdrawn. The cyst collapsed and the walls were marsupialized. The patient made an uneventful recovery and has been under observation for four and a half years. Roentgen examination at the end of four years showed the transverse colon in normal position with return of the haustral markings.

There may have been a pre-existing small simple serous cyst, but even if there were, the trauma was of primary importance in creating the condition found on operation.—*Audrey G. Morgan.*

Huidobro, F., Montero, E., and Cuevas, F. The effect of certain drugs on the motility of the jejunoileum in normal man. *Surg., Gynec. & Obst.*, May, 1944, *78*, 471–476.

The movements of the jejunoileum and the action of drugs commonly indicated for use in relation to this part of the digestive tract were studied in 11 normal volunteers without evidence of digestive disturbances. The movements were recorded on a kymogram from a Mary tambour connected with the balloon of a Miller-Abbott tube introduced into the intestine 2.5 to 4.5 feet below the pylorus.

1. Amyl nitrite decreased markedly the intestinal movements and the tonus of the jejunoileum. The effect was brief.

2. Nitroglycerine did not affect intestinal movements.

3. Theophylline ethylenediamine (cardiomine Collier) acted like amyl nitrite but less intensely and for a longer time.

4. Methyl octenylamine (octinum Knoll) and diphenyl diethylaminoethanol hydrochloride (trasentin Ciba) decreased markedly the amplitude of the intestinal movements for more than sixty minutes and tended to decrease the tonus.

5. Pitressin and prostigmine increased the spontaneous motility of the small intestine; the effect of the former was more intense and more constant than that of the latter.

6. Atropine sulfate and morphine sulfate decreased the motor activity of the jejunoileum. The former may cause the exaggerated motility produced by pitressin to disappear, and the latter, in a large dose, may cause the intestinal movements almost to disappear and slightly increase the tonus.—*Mary Frances Vastine.*

Jungmann, H. Hodgkin's disease of the stomach. *Brit. J. Radiol.*, Dec., 1943, *16*, 386–387.

There are few proved cases of Hodgkin's disease of the stomach. A case is described in a man of sixty who for some time had had inter-

mittent abdominal pain and for about two months severe pain around the umbilicus after meals. Otherwise he was fairly well; appetite normal, no vomiting, Roentgen examination showed generalized disease of the stomach of the nature of a hypertrophic gastritis with infiltration of the deeper layers. Roentgenograms are given. The appearance was that of a widely infiltrated cardinoma extending almost to the cardia. Total gastrectomy and splenectomy were performed. Pathological examination showed Hodgkin's disease infiltrating all coats with an especially large number of proliferated reticulum cells.

There are three types of Hodgkin's disease of the stomach: an ulcerative type with multiple flat ulcerations, a tumor-like type usually situated in the prepyloric region, and changes involving the whole stomach which have been described under the heading of polyposis of the stomach. This case belongs to the last type. Although peristalsis was very sluggish in this case it was not entirely absent as it is in cases of extensive malignant infiltration. This may be used as a differential point between Hodgkin's disease and cancer.—*Audrey G. Morgan.*

Good, C. Allen. Entero-enteric intussusception. *Radiology*. Feb., 1944, *42*, 122–127.

The most common type of intussusception, the ileocolic, is generally seen in infants but the entero-enteric type, involving only the small intestine, is frequent in adults and may be chronic. Generally there is some underlying cause for such an intussusception, such as tumor, invagination of a Meckel's diverticulum, enlargement of a mesenteric lymph node, ulceration of a Peyer's patch, stenosis or adhesions. Clinical diagnosis is more difficult than in the other forms as the appearance of blood in the stools occurs late and the tumor is often so small that it is not palpated. Roentgen examination after giving a barium meal by mouth shows gradual narrowing of the lumen of the bowel as it approaches the intussusception; marked narrowing of the lumen through the intussusception; retrograde filling of the space between the intussusceptum and the intussuscipiens and the formation of a "concentric ring" or "spiral sheath" image. There is a palpable mass at the site of the filling defect in the barium. Though the roentgenogram or screen examination shows the insussusception it usually does not reveal the cause of it.

It is not safe to give barium by mouth unless it is known that there is no obstructive lesion in the colon. It is a good idea, therefore, to study the colon by means of a barium enema before attempting to examine the small intestine. If there is no lesion in the colon barium can be given safely by mouth.

Three cases of entero-enteric intussusception are described and illustrated.—*Audrey G. Morgan.*

Hurst, Arthur. Dyschezia andmega colon. *Radiology*, Feb., 1944, *42*, 128–135.

The author criticizes a paper published by Delano, Ronayne and Boland in the December, 1941, number of *Radiology* in which they say that dyschezia is merely a misnomer for megarectum. Hurst holds that these are two entirely different conditions. Dyschezia is difficult defecation caused by neglect or disregard of the conditioned or habit reflex on which evacuation is based. It can be cured by restoring the defecation reflex to activity. Usually an explanation of the physiology of defecation and a restoration of the habit is all that is needed. If the patient is still unable to empty the rectum, even though it is loaded with feces, an enema of a fluid ounce of glycerine should be given in the morning after an unsuccessful effort has been made. The strength of the enema should be gradually reduced until the normal defecation reflex is restored.

Megacolon is due to achalasia of the anal sphincter or a failure to relax when the rectum contracts during defecation. This leads finally to enormous dilatation of the colon and hypertrophy of its walls from the increased peristalsis used in an effort to overcome the obstruction. Improvement in function is the thing to be aimed at in treatment. Once the colon has been greatly distended it remains distensible and if an opaque enema is given it may distend to its former size, giving the patient the idea that nothing has been accomplished. The resistance of the closed anal sphincter must be overcome. This is best attained by the use of a conical vulcanite bougie which is passed every morning after an attempt has been made to evacuate the bowels. It is perforated along its axis to allow the escape of gas from the intestine. After it is passed, a second attempt is made to defecate which is usually successful. In children the colon must often be evacuated by lavage and the use of the finger. Once it is emptied the patient is

usually able to have an evacuation every day. No aperients should be given but it may be necessary to give paraffin to prevent the feces from becoming hard.

Recently various operations have been performed on the sympathetic nervous system with the object of reducing the tone of the anal sphincter. It has been found that when spinal anesthesia is given for these operations the condition is relieved even though no operation is performed. The author advocates giving a spinal anesthetic without sympathectomy when there is difficulty in emptying the rectum and pelvic colon by enemas alone.

On page 190 of the same journal Delano replies to Hurst's criticism of his paper. He holds that Hurst's reasoning is confused and that dyschezia is not a clinical entity.—*Audrey G. Morgan.*

Lichtman, A. L., and McDonald, John R. Fecal fistula. *Surg., Gynec. & Obst.*, May, 1944, *78*, 449–469.

This investigation was undertaken in an attempt to provide a sound basis for the study of the causes of persistence of fecal fistulas and the utilization of this knowledge in the application of the proper treatment for the cure of the fistula. From 1930 to 1941, inclusive, 590 cases of fecal fistula were encountered at the Mayo Clinic. In 58.2 per cent of these the external opening was in the right lower quadrant of the abdomen.

Classification.

1. Cause. Congenital, Most fistulas of congenital origin terminate at the umbilicus and represent a patent omphalomesenteric duct. They are rare. None was found in this series.

2. Acquired. *Pathologic or spontaneous fistulas* follow spontaneous rupture of a section of the intestinal wall due to infection, malignant lesion or impeded circulation. *Traumatic fistulas* include those following gunshot wounds, perforating wounds and fecal fistulas associated with compound fractures and hemorrhages. *Postoperative fistulas* include: (1) intentional, those operatively created for decompression in obstruction, to rest a diseased section of bowel, or prophylactically to protect a freshly sutured bowel; (2) accidental, those following operations involving malignant lesions, and those following inflammatory lesions of the intestines. The fecal fistula usually appears in the immediate postoperative period. Occasionally, however, there is an interval of as much as six to twelve months between the operation and the development of the fistula.

Pathologic Anatomy. The presence of foreign body giant cells laden with small cotton fibers in the wall of persistent fistulas suggests the danger of the vigorous swabbing, grasping, and packing with dry gauze so widely practiced. The lint left behind on the delicate peritoneal surface is visible on careful inspection during an operation. Although cotton suture itself may not arouse much of a reaction, finely divided lint plus pressure or bruising injury to the peritoneum stimulates a proliferative fibrous reaction with the formation of fine adhesions. Combined with the formation of a fistula this rather minor reaction is enough to cause persistence of a fistula otherwise predisposed to heal spontaneously. Similar proliferations are produced by talc, petrolatum, or lycopodium.

Factors which maintain fistulas.

1. There is a distinct, active lesion in the intestinal wall at the fistulous opening which prevents spontaneous closure. Operative closure can be successful only if this diseased segment is excised.

2. Foreign substances such as cotton fiber, talc, lycopodium, petrolatum, and products of degeneration embedded in the fistulous tract itself may alter the processes necessary for spontaneous closure of the fistula.

3. The defect or diseased portion in the intestinal wall may be too large for spontaneous closure, since contraction of scar tissue sufficient to close the fistula would produce constriction of the intestinal lumen. Here also resection of the diseased though quiescent segment of the intestine is essential for closure of the fistula.

Summary. The authors emphasize that in the majority of the cases active intestinal lesions, such as regional enteritis or the presence of some granuloma-stimulating microscopic foreign substance was found. It is maintained that the persistence of fistulas after appendectomy for acute appendicitis is due to an ulcerative or granulomatous lesion of the region, an abscess cavity, gangrene, or constriction of the intestine below the fistula. Fistulas resulting simply from the pressure of drains, misplaced sutures, the nicking of the intestine, inversion of the appendiceal stump or failure to invert it, will heal spontaneously. Persistence of the fistula is evidence of an inherent lesion of the intestinal wall or a microscopic or macroscopic foreign substance.—*Mary Frances Vastine.*

Robertson, H. E., and Dochat, George R. Pregnancy and gallstones; collective review. *International Abst. Surg.*, March, 1944, *78*, 193–203.

It has been frequently stated that "90 per cent of all women who have gallstones have also borne children." The authors decided to test the validity of this generally accepted remark. They analyzed the records of 16,936 cases in which postmortem examination was performed at the Mayo Clinic during the years 1910 to 1942 inclusive. The cases included only those in which opportunity was afforded for the examination of the gallbladder and bile ducts. The following conclusions were reached:

1. Gallstones occur more frequently (twice or three times) in women than in men.

2. Many writers followed Schroeder and Naunyn when they announced that 90 per cent of women with gallstones had also borne children, and all of these writers, therefore, concluded that pregnancy was conducive to the production of gallstones and accounted largely for the increased incidence of gallstones in women.

3. Estimation of the relative number of married women who remained childless (13 per cent) plus the relative number of single women (7.8 per cent) gave the total relative number of women who had never borne children (20.75 per cent); therefore, about 79.25 per cent of all women have had children.

4. This last figure (79.25 per cent) corresponds very closely to the number of women with gallstones who had borne children. This latter figure in the postmortem series was 84 per cent. In the combined series reported by thirty-four authors, 11,154 of 14,016 women with gallstones had had children, an average of 79.6 per cent.

5. There is also some evidence that gallstones occur earlier in women than in men.

6. Thus it would appear that pregnancy cannot account to any great extent for the increased incidence of gallstones in women.

7. The solution of these problems as well as that of the real cause of gallstones still remains a considerable mystery.—*Mary Frances Vastine.*

GYNECOLOGY AND OBSTETRICS

Snow, William, and Nadel, Milton. Roentgen study of the fetus in utero. *Radiology*, Feb., 1944, *42*, 136–142.

The authors have made roentgen studies in over 2,500 cases of pregnancy in which abnormalities were suspected. By such examinations they can determine the size and age of the fetus, fetal death, normal and abnormal fetal positions, extension or deflection of the fetal head, engagement of the fetal head and congenital and acquired diseases.

There is not enough lime in the bones of the fetus for roentgen visualization until it is about fourteen weeks old. From this time on, its age can be estimated from the roentgenogram which should be taken in a lateral view. The fetal size and age can also be determined from the occipitofrontal diameter of the head. Weight can only be estimated and not always with complete accuracy. The first sign of fetal death is overlapping of the skull sutures. Later the spine may become abnormally curved and the fetus may assume positions which are obviously abnormal. The normal and abnormal positions of the fetus and extension and deflection of the head are discussed. Patients are rarely sent for roentgen examination after the head is engaged, for after the head has descended well into the pelvis there is little likelihood of dystocia.

There are many forms of fetal monstrosity and in all cases of cesarean section it is well to make a roentgen examination before operation to avoid delivery of a monster. One of the most common fetal abnormalities recognized in utero is acrania or anencephaly. It shows geometric soft smooth shadows surrounding the fetus and a thick layer of subcutaneous fat manifested by a broad black line of demarcation. Elephantiasis congenita is shown by extensive deposits of fat around the fetus. In symmelus or mermaid there is a greater or less degree of fusion of the bones of the lower extremities. Osteogenesis imperfecta shows deformity of the bones, usually with multiple fractures. In hydrocephalus the head is enormous. Premature closure of the sutures or unusual thickening of the skull may interfere with moulding and cause dystocia. Other abnormal fetal conditions that may be recognized are extensive spina bifida, hemivertebrae, supernumerary digits, syphilis, rickets, and fractures.—*Audrey G. Morgan.*

Moir, Chassar. Fallacies in soft tissue placentography. *Am. J. Obst. & Gynec.*, Feb., 1944, *47*, 198–211.

This study is from the Department of Obstetrics and Gynecology, University of Oxford. A representative series of roentgenograms was obtained from normal patients in the last eight

weeks of pregnancy. A critical analysis was then made of some 30 roentgenograms selected because of technical superiority. The following conclusions are reached:

1. Experiments show that the dark band surrounding the fetus in utero is the result of the relative transparency of the subcutaneous tissue of the fetus. It does not represent amniotic fluid. The conclusions of Weintraub and Snow are in the main confirmed.

2. Experiments are described which prove that the uterine wall, the placenta, and the amniotic fluid are all similar in radiopacity. a local collection of amniotic fluid (caused by an uneven position of the fetus in utero) gives a shadow indistinguishable on ordinary examination from placental tissue. The shape of the shadow may give a clue to its identity but certainty in diagnosis is seldom possible on this basis alone.

3. Critical examination of previous work raises doubt regarding the accuracy of the interpretation of the experimental finding. In some of the roentgenograms the thickness of the "placenta" considerably exceeds the thickness of the normal organ.

4. The deep indentations frequently seen on the "placental" surface can readily be explained on the basis of the fluid nature of the shadow-producing substance.

5. In test cases, the localized thickening of the uterine wall shadow (the placental site according to the original definitions) disappeared when external pressure was applied.

6. In test cases, air introduced into the amniotic sac revealed a uterine wall of normal thickness at the site of the supposed placenta.

7. Positive findings from this method of placentography should be accepted with reserve; negative findings may have a limited field of usefulness.—*Mary Frances Vastine.*

GENITOURINARY SYSTEM

Abeshouse, B. S. Surgery of the congenital anomalous kidney. *Surg., Gynec. & Obst.*, March, 1944, *78*, 288–303.

It is generally agreed that congenital anomalies occur more frequently in the kidney than in any other organ in the body. The most common renal anomalies encountered are fused supernumerary kidney, polycystic kidneys, congenital hypoplastic kidney, congenital ectopic kidney, and horseshoe kidney. The intrinsic lesion in a congenital anomalous kidney may manifest itself in one or more of the following changes: (1) extensive histopathologic changes associated with defective development of the fetal kidneys, i.e., embryonic, sclerotic or calcified glomeruli and tubules, cystic degeneration, etc.; (2) hydronephrotic atrophy secondary to congenital obstructive lesions in the upper or lower urinary tract; (3) renal atrophy secondary to anomalous blood supply; (4) various types of inflammatory or suppurative lesions of the renal parenchyma due to acquired infection; (5) calculosis secondary to obstruction or infection.

Renal Aplasia and Hypoplasia. Aplasia indicates a faulty developed kidney which is much smaller than normal and is composed of embryonic or calcified glomeruli or tubules. The hypoplastic kidney is well developed from an anatomic and histologic standpoint but is diminutive or infantile in size. The aplastic kidney is usually functionless while function in the hypoplastic kidney is diminished. Renal aplasia is a rare anomaly.

Supernumerary Kidney. When two separate pelves are found to be free or fused on one side, the upper pelvis is usually rudimentary and the parenchyma is hypoplastic, whereas the lower pelvis is well developed and the parenchyma possesses normal or near normal function. When the two pelves are intimately adherent or fused together, the anomaly is known as a fused supernumerary kidney. This is the most common renal anomaly. According to Campbell the incidence is 1 in 195 cases. The surface of such kidneys may be smooth and uniform or show a definite groove or constriction at the junction of the two segments. When the upper rudimentary segment is distinctly separate, the anomaly is considered as a true or free supernumerary kidney.

The ureters in either anomaly may show a complete or incomplete duplication. When complete duplication is present, the ureter of the upper pelvis is straighter and narrower than its mate. The orifice of the ureter to the lower pelvis is most frequently found to be superior and lateral whereas that of the upper pelvis is medial and inferior. The common site of the bifurcation in incomplete duplication is in the upper third and least often in the lower third.

Horseshoe Kidney. This is one of the common renal anomalies. Campbell found 60 cases in 26,480 necropsies. The pathologic changes asso-

ciated with urinary stasis are more frequently noted in this anomaly than in the normally developed kidney. This is due to interference with drainage from the pelvis and ureter which may be caused by abnormal rotation of the pelves, lateral exit of the ureter from the pelvis, and compression of the ureter over the isthmus or by anomalous blood vessels.

Sigmoid Kidney. This is one of the rarest types of renal anomalies. Young distinguishes two types: (*a*) the true sigmoid kidney—each kidney on the correct side of the body but the fused portion is situated in the midline of the body, and (*b*) the unilateral elongated (or fused) kidney—both kidneys fused on the same side of the body—a crossed dystopia.

Renal Ectopia. The ectopic kidney is a congenitally misplaced kidney which has failed to ascend to its normal position. It is usually found within the true pelvis or at the level of the sacral promontory. It is to be distinguished from the acquired dystopic kidney (nephroptosis) whose variable mobility may be due to intrinsic or extrinsic factors. It is generally recognized that slight degrees of congenital displacements are not unusual but marked degrees of displacements are relatively rare. The congenital ectopic kidney is usually unilaterally displaced on the side that it normally belongs, but occasionally may be of the crossed dystopic variety.—*Mary Frances Vastine.*

McDonald, John R., and Priestly, James T. Malignant tumors of the kidney; surgical and prognostic significance of tumor thrombosis of the renal vein. *Surg., Gynec. & Obst.*, Sept., 1943, *77*, 295–306.

In cases of hypernephroma of the kidney, the presence of tumor thrombosis of the renal vein is of definite prognostic significance. The prognostic significance is comparable to that of involvement of the lymph nodes in cases of carcinoma of the breast or gastrointestinal tract.

Method of Study. In order to determine the incidence of tumor thrombosis of the renal vein and the effect of such thrombosis on the ultimate survival rate after nephrectomy for malignant neoplasm, a dissection was made of the vein, artery, and their tributaries in the hilum of every kidney that had been removed because of a malignant neoplasm at the Mayo Clinic in the years 1904 to 1940 inclusive. In all, approximately 700 kidneys were examined.

Hypernephroma. The tumor was a hypernephroma in 509 of 636 cases. Malignant thrombosis of the renal vein was present in 54 per cent of these cases. It is thus not surprising that the lung is the usual site of metastatic involvement in cases of hypernephroma. The artery and lymphatics about the hilum of the kidney were not invaded by this tumor. Bizarre metastatic involvement of the spinal column can readily be explained by anastomosis of the renal veins with those of the paravertebral venous system (Batson).

Carcinoma of the Renal Pelvis. In 11.9 per cent of the series, the neoplasm was a carcinoma of the renal pelvis. Involvement of the lymphatics in the hilum of the kidney or tumor thrombosis of the renal vein or both were present in 44.7 per cent of the cases of carcinoma of the renal pelvis. In these tumors, metastasis usually occurs in the periaortic lymph nodes or in the lungs.

Wilms' Tumor. Tumor thrombosis of the renal vein or involvement of the perineural lymphatics or both were present in 14, or 42.5 per cent of the cases of Wilms' tumor.

Sarcoma. Tumor thrombosis of the renal vein was present in only 2 of the 20 cases of sarcoma of the kidney. Involvement of the perineural lymphatics was not encountered in any of these cases. It would appear that in this tumor and in the Wilms', neoplastic cells enter the vessels in the kidney and metastasize from this point.

Prognostic Significance of Tumor Thrombosis of the Renal Vein. In cases of carcinoma of the renal pelvis, the prognostic significance of tumor thrombosis of the renal vein or involvement of the lymphatics is greater than it is in cases of hypernephroma. The presence of tumor thrombosis of the renal vein or involvement of the perineural lymphatics or both apparently have little influence on the five year survival rate in the cases of Wilms' tumor. In cases of sarcoma of the kidney, the presence of thrombosis of the renal vein does not appear to be of prognostic significance.—*Mary Frances Vastine.*

Leary, Deborah C., and Peters, John P. Intravenous pyelograms in normal and abnormal pregnancies. *Am. J. Obst. & Gynec.*, Dec., 1943, *46*, 803–809.

Dilatation of the ureter in pregnancy has been repeatedly recognized in the past hundred years. The present study was undertaken in an attempt to determine whether toxemia of pregnancy and urinary tract infection in pregnancy would have any significant effect upon changes

in the urinary tract generally accepted as physiologic, viz., dilatation of the ureter. A group of 108 women in various stages of pregnancy and the puerperium were studied by means of intravenous pyelography. Diodrast was used throughout. In all, 113 pyelograms were taken. Five patients were examined twice.

Summary of Findings.

1. Twenty-three normal pregnant and puerperal women showed the changes usually associated with pregnancy. This ureteral dilatation (above the pelvic brim) does not ordinarily begin until the sixteenth week or later.

2. Post-partum studies in the normal group revealed regression to be rapid and in the majority of instances complete by the tenth day. No conclusive difference in relation to parity could be demonstrated.

3. Studies of 81 women whose pregnancy was complicated by toxemia or urinary tract infection revealed that in this group dilatation appeared as early as eight to twelve weeks and post-partum regression was far less frequently complete by ten days. When the infected group (26 patients) were assessed separately, these differences were exaggerated.

4. The reason for this delayed regression in toxemic women is not clear.

5. It is concluded that urinary tract infection and toxemia enhance the normal tendency to dilatation of the urinary tract in pregnancy and interfere with the usual prompt regression of these changes.—*Mary Frances Vastine.*

Chamberlin, George W., and Payne, Franklin L. Urinary tract changes with benign pelvic tumors. *Radiology*, Feb., 1944, *42*, 117–121.

The authors review the literature of the subject and discuss 96 cases of benign tumors of the pelvis in which they have studied the patients by excretory urography since 1937. Of these patients 66 (or 68.7 per cent) showed roentgen evidence of either displacement or obstruction of the ureters or both. There was obstruction in 47.9 per cent, displacement in 12.5 per cent and both in 8.7 per cent. There were urographic changes in 72.5 per cent of the patients with myomas, 43 per cent of those with ovarian cysts and 80 per cent of those with both cyst and myoma. This does not agree with the finding of Kretschmer and Kanter that changes are more frequent with ovarian cysts than with myomas. The size of the tumor has some effect on the degree of displacement or retention but the authors think the position of the tumor in relation to the pelvic ureter is more important than its size. Impacted or intraligamentous tumors caused the greatest changes.

The changes seen in these cases were qualitatively the same as those seen in pregnancy but were usually less pronounced. The changes in pregnancy are often attributed to hormones but these cases furnish evidence that the changes in pregnancy may be caused by pressure also. The urographic findings do not show the type of pelvic tumor. However, absence of function of one kidney is indicative of malignancy, while simple displacement or retention is more apt to result from benign tumor. All of the changes described here disappeared completely after operation.

The authors recommend excretory urography as a valuable preoperative study in cases of benign pelvic tumor.

In the discussion Dr. Gardner said he doubted the great value of urography in these cases. Too often the part of the ureter that is obstructed or displaced so that it might be injured during operation does not show in the urogram. There are better methods of demonstrating the exact location of the ureter, such as stereoscopic study of retrograde pyelograms or by leaving ureteral catheters in place so that they can be palpated during operation. He also said he believed the authors should have recorded the number of children the patients had for he believes there is always some residual atony of the ureter after delivery and multiparous women would therefore show greater ureteral dilatation with lesser degrees of pressure from tumor than nulliparous ones.

In closing, Dr. Chamberlin agreed with Dr. Gardner in regard to the question of residual atony of the ureter after pregnancy. He also said that in some cases of intraligamentous or incarcerated tumor the lower ureter cannot be demonstrated, but if it can it is of great value in operation.—*Audrey G. Morgan.*

ROENTGEN AND RADIUM THERAPY

Figi, Frederick A., New, Gordon B., and Dix, Christopher R. Radiodermatitis of the head and neck with discussion of its surgical treatment. *Surg., Gynec. & Obst.*, Sept., 1943, *77*, 284–294.

Chronic radiodermatitis is encountered fairly frequently. It occurs more often following

roentgen therapy than after radium treatment and the former is usually of greater seriousness because of the more extensive area involved. The tendency of irradiation to induce serious cutaneous changes is increased by rays from other sources, such as sunlight and ultraviolet and infra-red irradiation as well as chronic irritation of other types. The skin of certain persons is unduly sensitive to irradiation, either because of lack of normal pigment or because of an idiosyncrasy. Excessive reaction is observed particularly among those who have a fair or ruddy complexion, red hair or a thin, dry skin.

Radiodermatitis may occur either as an acute process reaching its height within a few weeks following exposure to the rays or as a chronic condition becoming manifest only after the lapse of months or years. The acute form is comparable to the three stages of burns except that the process progresses much more slowly. A dusky blue erythema is noted at the end of two weeks and either exuding or dry dermatitis after three weeks. A permanent brown discoloration due to increase of melanin and temporary or permanent loss of hair may follow this.

The necrosis, sloughing, and secondary infection of this stage often produce protracted disability, for healing occurs only after many weeks or months. The most destructive effect of the irradiation occurs in a central area and gradually decreases toward the periphery of the exposed surface. Months after the delayed healing the central portion of the area may break down again and the prolonged, painful sloughing and ulceration recur. Chronic radiodermatitis is usually preceded by the acute form, a latent period of from one to ten years generally intervening.

Pathology.

1. Complete loss of the appendages of the skin.
2. The replacement of normal collagen by a peculiar dense hyaline collagen.
3. Obliteration of the small vessels in the corium of the skin and subcutaneous tissues.
4. Necrosis and rarefaction in the corium usually associated with thrombosed regions of telangiectasia.
5. Reparative proliferation with hypertrophy of the epidermis.

Treatment. The acute stage is self-limiting unless excessive reaction is present and surgical treatment is contraindicated during this period. The chronic stage is progressive and there is a decided tendency for epithelioma to develop. Surgical removal is the only means of controlling the condition when secondary irradiation changes are pronounced. The surgical technique employed by the authors in the treatment of chronic radiodermatitis of the head and neck is given in detail.—*Mary Frances Vastine.*

Byars, Louis T. The "malignant" hemangioma. *Surg., Gynec. & Obst.*, Aug., 1943, 77, 193–198.

In infants, the arterial hemangioma must be given close consideration because of its tendency to spread, to deform or destroy features, to invade deep tissues and, in some instances, to produce death. This type may certainly be termed malignant. It is stated in medical literature that such birthmarks may disappear spontaneously. Except for the light reddish, splotchy areas over the back of the neck and between the brows frequently seen in infants, it is doubtful if such recession occurs.

Age of Treatment. Often the hemangioma appears in the first month of life. The proper time for treatment is as soon after appearance of the lesion as possible.

Choice of Treatment.

1. Portwine stain. This lesion involves the full thickness of the skin, is a reddish purple blotch, and grows only as the child grows. It is not sensitive to irradiation as a rule.
2. The venous angioma. This consists of large channels filled with venous blood; its growth is slow. Treatment is surgical. Occasionally, the interstitial use of radon is helpful.
3. The arterial angioma.
   a. Cautery destruction or surgical excision should be considered first and as early as possible.
   b. The carbon dioxide ice freezing method should be used only for entirely cutaneous lesions.
   c. Surface radiation should be done with radium rather than roentgen rays. The author feels that the interstitial implantation of gold radon seeds is the most valuable single method of therapy for "malignant" arterial angiomas. Usually, seeds of 0.25 millicurie should

be employed. The total dosage may usually be calculated as one radon seed per cubic centimeter of tissue to be irradiated.

Complications.

1. Ulceration of the tumor. This appears spontaneously without trauma in many cases.
2. Secondary deformity.
3. Recurrence. Secondary treatment may be necessary if some portion of the tumor is not controlled at the original treatment.
4. Late surgical repairs.
5. Retention of gold seeds. There is no tissue reaction to the gold seeds which are contained in the tissues. Occasionally they may be visible under the skin and if so, they may be removed later.

Response to Treatment. The more rapidly growing hemangioma responds more readily than does the slower growing one. Ideally, progressive improvement should occur over a period of six months to a year in cases in which the minimum but adequate dosage has been used.—*Mary Frances Vastine.*

Warren, Shields, and Tompkins, Victor N. Significance of the extent of axillary metastases in carcinoma of the female breast. *Surg., Gynec. & Obst.*, March, 1943, *76*, 327–330.

The most important factor in predicting the survival of patients with carcinoma of the female breast after operative treatment has proved to be the presence or absence of metastases to lymph nodes in the axilla. It is generally agreed that the five year curability by surgery of operable cases in which the disease is limited to the breast is about 70 per cent, while that of the operable cases in which there are metastases to lymph nodes is about 23 per cent. So far it has been customary to note the presence or absence of lymph node metastases without determining the number of nodes involved. The 171 patients for this study were selected on the basis of available pathological material from those treated at the Pondville Hospital from 1927 to 1936 inclusive. The results of the study were:

1. *Effect of extent of axillary metastases.* The most significant finding is that curability on the basis of "five year cure" or longer periods of observation is inversely proportional to the extent of metastasis in the axilla. Fifty per cent cure in the group with least axillary involvement and 16 per cent cure in the group with most axillary involvement varies significantly from the average cure rate of 28 per cent for the whole group with axillary metastases. Seventy-seven per cent of those with all their lymph nodes involved were dead in two years whereas only 20 per cent of those with less than half their nodes involved died in a similar time.

2. *Effect of type of primary carcinoma.* It would seem that the type of tumor has less significance in prognosis than its extent. The breast tumors are not graded according to the method of Broders because the authors believe the personal equation in the process to be very great and the results have not been found to be significant.

3. *Recurrences in the operative scar.* For this series at least, recurrences in the operative scar increased with the extent of the disease in the axillary lymph nodes. It is reasonable to suppose that patients in whom metastases have occurred to axillary nodes should also have other metastases to the skin or the chest wall, thus increasing the likelihood of recurrence in the scar. The incidence of recurrences in operative scars suggests that they are of the nature of metastases or extensions rather than implants. —*Mary Frances Vastine.*

Mazer, Charles, and Greenberg, Rose. Low-dosage irradiation in the treatment of amenorrhea; analysis of an additional ninety-two cases. *Am. J. Obst. & Gynec.*, Nov., 1943, *46*, 648–654.

The authors summarize their article as follows:

1. A follow-up for nearly three years of 92 additional cases of amenorrhea, treated by means of low-dosage irradiation of the pituitary gland and ovaries, shows that 65 (72 per cent) of the patients have been menstruating normally.

2. The data gathered from a long-term follow-up of 165 cases, similarly treated and previously reported, show permanency of the cures and the safety of the procedure to both the patient and her offspring.

3. Of the 92 amenorrheic patients in the present group, 54 desired offspring but had not conceived despite the intensive use of organotherapy and other measures for several years. Twenty-eight (54 per cent) of the 54 barren women conceived and carried to term healthy

infants; 2 aborted during the first trimester of pregnancy. All of the 30 women have been menstruating normally since the termination of pregnancy.

4. A survey of the literature on low dosage irradiation of the pituitary gland and ovaries, as employed for the relief of amenorrhea, reveals no adverse effects either on the patients or their offspring.

5. Technique of irradiation: 135 kv., 5 ma., at a distance of 35 cm., with 0.25 mm. Cu and 1 mm. Al filtration through an anterior pelvic field. A dosage of 50 to 90 r, measured in air, is given and this is repeated three times at intervals of one week. The pituitary gland is treated with the same dosage at the same time through a field of 5 by 5 cm. just above and posterior to the mid-point of a line joining the outer canthus of the eye and the external auditory meatus.—*Mary Frances Vastine.*

Miller, Norman F. Consideration of certain factors pertaining to the control of carcinoma of the cervix. *Am. J. Obst. & Gynec.*, Nov., 1943, *46*, 625–634.

Cancer destroys more lives than the combined toll from tuberculosis, diabetes, appendicitis, cirrhosis of the liver, alcoholism, and automobiles.

In 1931, the Gynecology Tumor Conference was inaugurated at Ann Arbor. Since this time, nearly 2,000 carcinomas of the female generative tract have been carefully evaluated and treated. Of this number, 65.8 per cent, or 1,235 were cervical cancers.

Quality of Treatment. A table which gives a panorama of five year survival rates since the turn of the century and in the hands of different investigators is enlightening. In some cases, surgery alone has been used, in others irradiation. In other instances a combination of the two has been employed. The highest survival rate is 58 per cent and the lowest 20 per cent. The author writes, "No one expects the impossible, but there is good reason to believe that therapy is disappointing."

Clinical Grouping—As used at the University of Michigan Hospital.

Group 1. Very early carcinoma of the cervix. This group includes the early suspicious, often unrecognizable clinically carcinomas of the cervix.

Group 2. Any clinically recognizable histologically proved carcinoma still confined entirely to the cervix.

Group 3. Carcinoma of the cervix with questionable parametrial thickening.

Group 4. All advanced carcinomas of the cervix.

Causes of Death. Patients with cervical cancer seldom die as a direct result of the neoplasm itself. In an analysis of the deaths among carcinoma patients to be reported by Dr. Russell deAlvarez, it was noted that in 66 per cent of the cervical cases death was the result of uremia, and/or impaired renal function caused by encroachment of the neoplasm or scar tissue upon the ureters.

Lay Education and Early Treatment. In 1933, the author reported an average time waste of 6.2 months prior to the patient's seeking medical advice. In 1941, R. M. Collins noted an average time waste of seven months between the onset of the first symptom and the first examination. When we consider the elaborate programs carried on by national, state and county organizations directed specifically toward the elimination of this time waste factor, the results of these efforts cannot be considered very encouraging.—*Mary Francis Vastine.*

MacDonald, Ian, and Budd, John W. Osteogenic sarcoma; modified nomenclature and a review of 118 five year cures. *Surg., Gynec., & Obst.*, Oct., 1943, *77*, 413–421.

The authors present a review of 118 five year cures and 47 fatal results of osteogenic sarcoma of bone. They believe that the term "osteogenic sarcoma" is best used as a generic designation for the triad of connective tissue sarcomas primary in bone. This triad includes: (1) osteosarcomas (those sarcomas characterized by bone production), (2) fibrosarcomas, and (3) chondrosarcomas.

Summary of Findings.

1. True osteosarcoma is an almost uniformly fatal form of neoplasm.
2. Fibrosarcoma is a distinctly less malignant form of osteogenic sarcoma.
3. Chondrosarcoma seems to occupy a median position occurring in approximately equal proportions among the cured and fatal cases.
4. Encapsulation of osteogenic sarcomas is a favorable prognostic element. The amount of matrix has not been proved to be of prognostic value.

5. Natural selection determines curability to a greater degree than does early treatment for the delay in radical treatment is much greater in the cured than in the uncured neoplasms studied.
6. Biopsies were performed with more frequency in the cured cases than in the fatal cases.
7. The value of irradiation as a complementary curative agent in osteogenic sarcoma cannot be inferred from the data presented in this study. Actually, there is no significant statistical difference evident as a result of irradiation as approximately half of both the cured and uncured groups, in each of the three types of osteogenic sarcoma, were so treated. This does not imply that irradiation may not be of palliative benefit in many cases.—*Mary Frances Vastine.*

MISCELLANEOUS

QUIMBY, EDITH H. Some aspects of the teaching of radiological physics. *Radiology*, Oct., 1943, *41*, 315–329.

The author points out the importance of close cooperation between radiologist and physicist in teaching and emphasizes some of the points in which the teaching of radiological physics is apt to be defective. The general subject of radiological physics includes (1) the purely physical part, covering generation of roentgen rays, radioactivity, interactions of radiation and matter; (2) measurement of quality and quantity, including calculation of dosage; (3) calibration and records, and (4) protection. The first part is quite adequately treated in books and papers but when it comes to the interaction of radiation and matter and its practical application, books are not so satisfactory. The blame for defective understanding of these matters is laid on the teacher. Too often not enough emphasis is placed on the practical application of various points. The student is required to learn definitions and rules but is not made to work out problems that show that he understands them. The teacher should make certain that the student understands the application of his teaching before he is passed. Keeping up with current literature on the subject is very important. The matters of determining dosage and of protection are as a rule quite inadequately understood by the student. A wealth of detail in regard to various physical points in radiology are given and illustrated with charts useful in teaching.—*Audrey G. Morgan.*

CORK, J.M. Some recent applications of nuclear physics. *Radiology*, Oct., 1943, *41*, 337–343.

It has been found that by suitable treatment practically every known element can be rendered radioactive. At present over 340 radioactive isotopes have been produced and identified. These radioactive elements may emit electrons, positrons and gamma rays and have half-lives that vary from a fraction of a second up to many years. An equation can be written for each reaction but only the total energy, not the number of atoms, on the right and left sides of the equation is equal.

It is evident that by using radioactive or tagged detectable elements the behavior of matter may be followed in any field of science. Some of the practical applications of this fact in astronomy, botany, chemistry, engineering, metallurgy, mineralogy, pharmacology, zoology and medicine are described. In medicine the radioactive elements may be used as tracers to study physiological processes. Also neutron radiation may be used in the treatment of malignant growths just as roentgen rays are used, and radioactive elements may be selectively absorbed to treat specific organs. For instance, radioactive strontium may be used in the treatment of bone tumors, radioactive iodine for thyroid disorders and radiophosphorus for leukemia and polycythemia. Neutron radiation has been found to be many times more powerful than roentgen radiation. If it is also found to have a greater differential effect on diseased and normal tissue it will be of enormous importance.

The addition of a single neutron of low energy to the nucleus of the uranium atom may cause it to split into two parts, releasing an energy of about 186 million electron volts. In the process more neutrons are formed so that if the process were controlled it might go on spontaneously. This is one of the most challenging facts in the scientific world today and its importance cannot be overestimated.—*Audrey G. Morgan.*

LAMPE, ISADORE, and HODGES, FRED JENNER. Differential tissue response to neutron and roentgen radiations. *Radiology*, Oct., 1943, *41*, 344–350.

As soon as it was discovered that the qualitative effect of neutron and roentgen radiation

was the same, effort was directed toward finding whether there was any difference in their selective action on different tissues with a view to determining whether neutron radiation could be used effectively in the treatment of cancer. In 1927 experiments made by Ferroux and Regaud showed that permanent sterilization of the rabbit's testes could not be brought about by a single dose of roentgen rays without severely damaging the skin of the scrotum. These experiments have been repeated and their findings verified. Fractionating of the dose, however, does produce a somewhat more differential action on the two kinds of tissue. The relative biological effects of fast neutron irradiation were tested under the same experimental conditions and it was found that within a restricted range of dosage there is sufficient selective activity on the part of the irradiation to bring about aspermatogenesis without seriously damaging the skin. Tables are given showing the effects of roentgen and neutron irradiation in these experiments. Though the difference in selective tissue action between the two kinds of radiation may be slight it tends to show that neutron radiation may become more useful than roentgen radiation in the treatment of malignant tumors.—*Audrey G. Morgan.*

BEHRENS, CHARLES F. Some considerations of wartime radiology in the Navy. *Radiology*, Sept., 1943, *41*, 284–287.

The author stresses the necessity of training in radiology for Navy men and urges the doctors in the Navy to make the most of their chances at training in this specialty. Almost all ships are now provided with some sort of roentgen unit and these may be damaged by careless handling when the ship is far from port and necessary parts cannot be obtained, or the physician or patient may be injured by gross ignorance of means of protection. The more leisurely programs used in the Navy in times of peace are now in abeyance for the duration of the war. Officers interested in radiology were formerly given a year or more in the roentgen department of one of the larger naval hospitals, followed by a year in a civilian medical center. This of course is not possible now; generally officers are given six months or less of training and then assigned to work, if possible as an assistant. But often it is necessary to put them in full charge and they must make the fullest use of their training and also be resourceful in meeting situations that arise for which they have had no direct training. Not only must they understand mass fluorography but they must be acquainted with the lesser details of the profession, such as processing, care and conservation of apparatus and material, general technique, the use of small units and related matters.—*Audrey G. Morgan.*

MYERS, R. K. Federal regulations affecting allocation of x-ray equipment and supplies. *Radiology*, Sept., 1943, *41*, 288–290.

The author, who is chief of the X-Ray Section of the War Production Board, sets forth some of the regulations of that Board in regard to the allocation of x-ray apparatus and supplies. Unfortunately, many requests for such material must be refused. The best that can be done is to provide for minimum necessary requirements in civilian work. He urges civilian radiologists to bear in mind the tremendous demand for films for the Armed Forces and for industrial roentgenography, which has become a necessary and helpful factor in providing planes that can if necessary "fly on one wing," ships that hang together, armament that protects and ammunition that explodes. Bearing these things in mind the civilian radiologist should be as careful as possible in the use of films, tubes, etc. The War Production Board is there to help in every possible way and urges the cooperation of all radiologists.—*Audrey G. Morgan.*

CLARK, L. H., and JONES, D. E. A. Some results of the photographic estimation of stray x radiation received by hospital x-ray personnel. *Brit. J. Radiol.*, June, 1943, *16*, 166–168.

A photographic method of determining the amount of radiation to which roentgen-ray workers are subjected is described. The workers carry dental films in their pockets, half of each film being subjected to the stray radiation in the room. Each member of the staff carries a cassette loaded with films for a week. The films are then standardized by submitting the unexposed parts to small doses of roentgen rays, the kilovoltage and filtration of which are known. In this way the amount of stray radiation to which the worker is subjected can be determined.

The results of over 2,000 films assessed over a five year period under average working conditions are presented and the results given in a graph and table. It was found that workers are rarely subjected to the daily tolerance dose of 0.2 r per working day.—*Audrey G. Morgan.*

Quimby, Edith H., and Pool, John. Protection in radiology. *Radiology*, Sept., 1943, *41*, 272.

This article is made up of photographic reproductions of the charts from an exhibit prepared by request for a "Graduate Fortnight" meeting at the New York Academy of Medicine. With some revisions and additions it was presented in the Scientific Exhibit of the American Medical Association at St. Louis in 1939.

There are charts showing the need for protection in radiology, the local and general effects of roentgen and radium irradiation, the effects following long-continued exposure without protection, methods of protecting the doctor, the technician and the neighbors, the effect of distance from the roentgen tube and radium source on the thickness of lead required for protection, the lead equivalence of building materials, tolerance doses, tests for protection and the recommendations of the International Commission regarding the welfare of full-time roentgen-ray and radium workers.—*Audrey G. Morgan.*

Meredith, W. J., and Stephenson, S. K. Some physical measurements with a 500 kV continuously evacuated x-ray tube. *Brit. J. Radiol.*, Aug., 1943, *16*, 239–241.

Measurements are reported which were made on a Metropolitan Vickers' Continuously Evacuated x-ray tube operating at 500 kv. constant potential. Absorption coefficients for aluminum, copper, tin, lead and mild steel (as used in the tube body) were obtained for 500 kv. radiations with only the fixed filtration of the tube. Effective wave length values obtained from these measurements are in good mutual agreement. Since it was desirable from the clinical point of view to use the shortest wave length consistent with a reasonable output rate a filter of 3 mm. tin, 0.5 mm. copper and 1 mm. aluminum was used in addition to the fixed filtration. A stepped aluminum filter was used to equalize the intensity at points from 0° vertically downward to 110°. Measurements taken after this filter was fitted show how successful its use was.

A table is given showing percentage depth doses for different depths and various field sizes. These were obtained from measurements in a pressdwood phantom at 50 cm. focus-skin distance using 500 kv. with the tin filter, with a half-value layer equal to 6.32 mm. copper. The values found are lower than those of Mayneord and Lamerton. A part of this decrease is due to the fact that closed applicators were used. Also the absorption coefficient for pressdwood is greater than that for water, which must be considered the standard material for depth dose measurements. These two points are being investigated and the depth dose values given in the table should not be considered final.—*Audrey G. Morgan.*

Wilson, C. W. Some data concerning the use of x-ray beams in direct (cross-firing) opposition. *Brit. J. Radiol.*, Aug., 1943, *16*, 247–249.

In deep roentgen therapy, for instance irradiation of the axilla or pelvis, a favorite technique is to use two identical beams cross-firing through opposite fields. This is one of the simplest methods of getting a large dose at the center point between the two fields, where the pathological focus is located, as compared with the skin dose. The dosage conditions provided by such a technique depend on various physical factors, such as the quality of the radiation, focus-skin distance, size of fields and distance between the opposite fields. A good method of determining the efficiency of an opposing field technique is to determine the ratio between the dose midway between the two fields and the dose at either surface. This gives a measure of the effective depth dose provided by the technique. Curves are given showing the effect on such effective depth doses of field area, focus-skin distance and quality of radiation.—*Audrey G. Morgan.*

Bush, F. The estimation of energy absorption during teleradium treatment. *Brit. J. Radiol.*, April, 1943, *16*, 109–112.

The value of the integral dose or energy absorption expressed in gramme-roentgens in a beam of radiation between two specified limits of dosage can be calculated with sufficient accuracy from the isodose diagram by determining the volumes between successive isodose surfaces. The sum of the products of each of these with its respective mean dosage rate gives the energy absorption. Some of the isodose surfaces will be cut by the body surface and to measure the integral dose the size of the parts of the interdose volumes that lie inside the body must be determined.

This article describes a method of determining the parts of the isodose volumes lying inside the body and measuring the energy absorption in any given case. It is illustrated by a diagram

of the pantograph and planimeter used in the measurements and by tables showing the results in 26 cases of teleradium treatment of cancer of the mouth, pharynx, larynx and glands of the neck. The accompanying changes in the lymphocyte counts are also given as a means of correlating energy absorption and physiological effect.—*Audrey G. Morgan.*

Ungar, E. M. A simplified method of studying volume dose distribution. *Brit. J. Radiol.*, Sept., 1943, *16*, 274–278.

In order to cause complete disappearance of a malignant tumor an adequate dose must be given to every part of the tumor. Sometimes recurrence of a tumor takes place because the dose has fallen off from the center toward the periphery of the growth and the periphery has been inadequately irradiated. In order to get a uniform and adequate dose to all parts of the tumor the lesion must be located and reconstructed and its volume and extent determined before proceeding to the problems of beam construction, volume dose distribution and beam direction. A detailed description is given, illustrated with diagrams and charts for giving axially symmetrical dose distribution to circular fields. The method can, however, be applied also to square or rectangular fields. The method makes use of tinted charts in which decrease of dose is represented by a fading density of the color. An accurate and complete diagram of dose distribution can be produced by adding the values of dose contours at points of intersection and then joining points which have the same dose. The method of making these tinted isodose charts is described, and the construction of isodose volume distribution described. At the Royal Cancer Hospital the use of the tinted isodose charts and charted beam sections for constructing volume dose distribution has made it possible as a matter of daily routine to fit a planned dose distribution to the shape and volume of a given tumor. A study of the charts and diagrams would be necessary for an application of the method.—*Audrey G. Morgan.*

Bush, F. The calculation of dosage rates from directional caliper measurements. *Brit. J. Radiol.*, July, 1943, *16*, 205–207.

Two directional calipers are in use for dosage rate measurements, model 1 designed by Green for use in roentgen therapy and model 2 for use with a teleradium unit. The author here describes an alternative nomographic method of measurement which can be applied to both models 1 and 2 and which requires no special apparatus. The geometrical theory on which the method is based and the construction of the nomogram are described and illustrated and the equations by which the calculations are made are given.—*Audrey G. Morgan.*

Cook, H. F. An investigation of the absorption of gamma rays in surface therapy applicators. *Brit. J. Radiol.*, April, 1943, *16*, 115–118.

In measuring dosage in radium therapy it has been customary to ignore absorption and scattering in applicator and patient. But it was found that the dosage given by applicators was lower than that calculated by the rules of Paterson and Parker and this was assumed to be due to absorption in the applicator. Experimental evidence of applicator absorption is given and methods shown for calculating this absorption and also tissue backscatter for applicators made of Columbia paste and Stent wax. Tables are given showing the details of the results. The mean apparent transmission of each of the typical applicators used indicated that applicator absorption was of the order of 10 per cent.—*Audrey G. Morgan.*